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NEW YORK, OCTOBER, 1890.

THE production of pig iron in the United States for the first half of 1890, according to the statistics collected by the American Iron & Steel Association, was 5,169,737 net tons—an increase of 754,653 tons, or 17.1 per cent., over the second half of 1889, and of 1,068,742 tons, or 26.1 per cent., over the first half of 1889. Nearly every iron-producing district showed a gain, and the total production was the largest ever reported for a half year.

The gain was entirely in iron made with bituminous coal or coke, the charcoal and anthracite furnaces showing a slight decrease. As might have been expected, the increase in the output of spiegeleisen and Bessemer pig was large, showing that a continually growing proportion of the pig iron made is intended for conversion into steel.

The leading iron-producing States were Pennsylvania, which furnished 49.2 per cent. of the total output; Ohio, 13.2 per cent.; Alabama, 8.9 per cent., and Illinois 6.8 per cent. The furnaces of the Southern States supplied in all 18.6 per cent. of the entire production.

[THIS increased production of iron involves naturally increased consumption of ore; and we find, accordingly, that the shipments from the Lake Superior mines this year have amounted, up to the end of August, to 5,460,289 tons—an increase of 826,514 tons, or 17.8 per cent., over last year. An increased proportion of the ore comes from the newer districts; while the old Marquette Range supplied this year 33.1 per cent. and the Menominee Range 25.1, the Gogebic Range furnished 30.2 and the Vermilion Range 11.6 per cent. of the total shipments.]

LAKE steamers are built with especial regard to their carrying capacity; and the extent to which this has gone will be appreciated when it is stated that the new steamer *Maryland* on a recent trip brought down the enormous load of 3,702 net tons of iron ore from Escanaba to Chicago. The ship's draft, with this great load, was 16 ft. 6 in.; she is 335 ft. long, 42 ft. beam and 24 ft. deep.

In this connection it may be noted that the new "whale-shaped" steamer *Colgate Hoyt*—which was illustrated in the September number of the JOURNAL—on her last trip brought 2,706 net tons of ore to Cleveland. With this load she made 13 miles an hour on Lake Superior.

THE latest project for quick transit between Europe and America has been brought forward by Canadian railroad men, who propose the building of a railroad from Quebec to St. Charles Bay on the Labrador coast. The road will be some 850 miles long, and it is believed that fast steamers can make the voyage from St. Charles Bay to Milford Haven in Wales in 3½ days. Some English capitalists are already interested in the project, and their engineer is making a preliminary examination of the route. One drawback is that the railroad line would run through an almost uninhabited and desolate country, and would have no local traffic whatever.

THE great tunnel under the St. Clair River, between Port Huron and Sarnia, is practically completed, and the trains of the Grand Trunk Railway will soon run through, without the delay heretofore required for the ferry transfer, which was often considerable in the winter.

This tunnel is in all 6,050 ft. long, 1,850 ft. being on the American side, 2,300 ft. under the river and 1,950 ft. on the Canadian shore. It is circular in form, the outer ring being 21 ft. in diameter and composed of cast-iron segments bolted together and lined with masonry. It carries a single track, and it is proposed to build a second tunnel of similar dimensions when a second track is required.

The tunnel is chiefly through blue clay, and was excavated by the Beach pneumatic shield, driven forward by hydraulic pressure, the work being carried on from both ends. The shield is forced into the clay and protects the workmen while they are excavating it and placing the iron segments. In building the tunnel 2,196,400 cub. ft. of earth were removed; 27,976 tons of cast-iron and 850,242 bolts were used. The segments were put in position by a balanced circular crane of very ingenious design attached to the rear end of the shield.

THE successful completion of the St. Clair Tunnel has stimulated projectors, and a company has been organized to build a similar tunnel under the Detroit River from Detroit to Windsor. This would be about 3,000 ft. long under the river, and the approaches would be about 3,000 ft. on either side, making a total length of about 9,000 ft. The top of the tunnel would be 48 or 50 ft. below the water level, or from 13 to 15 ft. below the river bed at the center. The estimated cost is $3,500,000 for a single-track tunnel, and the plan is to have it open to all connecting railroads.

THE armor-plate trials at Annapolis took place on September 18 and 22, three plates being tried, a compound steel and iron plate 10.6 in. thick, from Cammell, of Sheffield, England; a steel plate 10.5 in. thick from the Creusot Works, and a nickel-steel plate 10.5 in. thick, also from Creusot. Four shots were fired at each from a 6-in. gun at a distance of 30 ft., and one from an 8-in. gun, Holtzer steel forged projectiles being used, with brown cocoa powder. The plates were set up with 36 in. of oak backing.

The result of the first test—the four 6-in. shots—was the practical destruction of the Cammell plate, which was penetrated, cracked and badly broken, being practically destroyed. The Creusot plates stood the test remarkably well, being but little damaged, in fact, and barely penetrated at all.

The Board having the tests in charge will make a full report, which will be read with much interest.

THE sale of agricultural machinery in the Argentine Republic is very large, according to a correspondent of the London *Engineer*, and is likely to extend. He mentions especially plows, reapers and thrashing machinery, and recommends that wherever possible the frames of machines should be of steel, and that boilers should be made to burn straw, as fuel is scarce and dear. Cast steel should be used in place of cast-iron, in fact, as much as possible, as lightness is a great object. American machinery is generally preferred.

Machinery for working ramie, which is not unknown in this country, would be valuable, but the only machines yet introduced are of French manufacture.

A rural exposition will be held in Buenos Ayres in 1892, which will give a very favorable opportunity, as these expositions are largely attended. The letter is written for English manufacturers, but might give a useful hint to some of those on this side of the water.

THE Khojak Tunnel, on the Indian Frontier line, from Quetta to Candahar, which is now nearly completed, is one of the great tunnels of the world. It is 12,600 ft. long, and is built for a double track. It was worked from the ends and from two intermediate shafts, which are respectively 318 ft. and 290 ft. in depth. The chief obstacle met with in excavating it has been the quantity of water met with at different points.

This Frontier Extension is considered a very important line from a military point of view, and the Indian Government is spending a great deal of money upon it, in anticipation of the time when an English army at Candahar will be called on to face a Russian force from Merv, with the Transcaspian line behind it as a base of supplies.

THE so-called "Zone system" of passenger tariffs, which was adopted some time ago on the Hungarian State Railroads, has excited much attention in Europe from its simplicity, the entirely new principle upon which it is based, and the great reduction in passenger fares made by it.

Under this system the railroads are divided into zones starting from a given center, the first zone including all stations within a radius of 25 kilometers from the center, while the remaining zones are 15 kilometers in width up to the fifteenth, that and the sixteenth each taking in a belt of 25 kilometers. The rates are established by zones, the fare from a station in any one zone to one in any other being found by multiplying the established unit by the number of zones to be crossed.

The system reduced rates largely, the reduction increasing with distance, and varying from a small amount for short distances to 90 per cent. for the longest distance, about 225 kilometers. The immediate result has been that passenger business on the Hungarian lines has more than doubled, and the gross receipts have increased, in spite of the reduction in rates.

IT is reported that the Chinese Government has finally decided to build a strategic railroad from Pekin to the Manchourian frontier, the object being to aid in the colonization of Northern Manchouria and to make it possible to move an army to the frontier in case of need. The report has not yet been confirmed, but if true, the moving cause is doubtless the fear that the Russians will push forward the Siberian Railroad and so place themselves in readiness for a movement into Chinese territory should they wish to make one.

Should the proposed line be built it may become an important line commercially, and aid in increasing the overland traffic between China and Russia, which is already large, both in amount and value, with the present imperfect means of transport.

A RAILROAD across the Sahara, from some point on the Algerian railroad system to Timbuctoo, is proposed, and French engineers have made some preliminary reconnoissances. The line, it is claimed, will draw to itself a considerable commerce, will promote and consolidate French influence in the Western Soudan, and will lead to the settlement of parts of the Sahara, which is not by any means the irreclaimable desert which the geographies of a few years ago asserted it to be. The line presents no great engineering difficulties.

THE Trans-Caspian Railroad, built by the Russian Government as a military line, is developing much commercial importance. As it followed substantially a line which has been a highway of commerce for centuries, it has taken the traffic formerly carried by caravans, and it is also doing much toward increasing the products of the country on its line, by furnishing them an outlet to market. The receipts of the road from commercial business in 1889 were 2,800 000 rubles, and so great has been the growth this year that it is estimated that they will reach more than double that amount, or 6,000,000 rubles.

THE Engineers of the Pennsylvania Canal Commission have very nearly completed preliminary surveys for the proposed ship canal, which is to connect the Ohio River with Lake Erie. Several lines have been run, the latest extending from the Ohio at Rochester to Lake Erie at Conneaut Harbor, with an alternate line to Elkwood Creek. The length of this line is a little over 100 miles, but not all of it would have to be canal, as the survey contemplates the use of the Beaver and Shenango Rivers by a system of locks and dams. It is understood that the Commission will report that there is ample water supply for a ship canal, and will recommend sites for several storage reservoirs. This report will be submitted to the Legislature as a basis for action on the canal project.

THE latest plan for crossing the British Channel and making a connection between the French and English railroads has been proposed by M. Bunau-Varilla, and is intended to obviate the political and military objections made to a tunnel, and at the same time the reasons given against a bridge crossing proposed by Messrs. Schneider and others. These objections were the great cost; the danger to navigation from the erection of bridge piers, and the fact that, as the bridge would cross the high seas which are under no one national jurisdiction, the consent

of all the maritime powers would be needed to its construction. M. Varilla proposes to build at either side of the Channel a bridge extending out to such a distance from the shore as may be determined by more careful surveys, and to build a tunnel under the central portion of the Channel. The connection between the bridge sections and the tunnel will be made either by inclined planes or by hydraulic elevators capable of transferring a whole train at once. He considers that the construction of the bridge sections will present no remarkable difficulties, since they will be in shallow water, while the transfer arrangements and the building of the tunnel can be easily managed. He thinks also that this arrangement will meet the objections made from a military point of view, since the bridge approach could be easily destroyed by a warship in case of necessity.

It has always seemed to us that these military objections to the tunnel amount to very little, since an invading army would be hardly likely to undertake a march through a passage which could be flooded in a few minutes, to the certain destruction of every one who might happen to be in it. They have always been urged in England, however, against the project for tunnelling under the Channel, and has been sufficient to defeat a bill granting the necessary permission in Parliament.

FROM a statement lately made to the general convention of German iron-workers, it appears that since 1886 there have been 1,668,179 metal ties laid on the Prussian State Railroads. During the fiscal year 1889–90 provision was made for laying about 600,000 more.

It also appears from the same statement that the average price for iron ties was $25.83 per ton (of 2,000 lbs.); for the clips or chairs for holding the rails, $65.38, and for the bolts, etc., $63.86 per ton.

At these rates ties of the Berg & Mark pattern, weighing 54 kg. (119 lbs.) each, cost, for the tie, $1.55 and for the fittings, 17 cents, a total of $1.72. Ties of the Hartman pattern, weighing 53 to 57 kg. (117 to 125 lbs.), cost from $1.50 to $1.62 for the tie, and 39 cents for the chairs, etc.; a total of $1.89 to $2.01 each. The results so far obtained have been very satisfactory.

THE interest felt in Europe in the canal system is shown by the International Congress on Inland Navigation, the fourth meeting of which was recently held at Manchester, England, the previous meetings having been at Brussels, Vienna and Frankfort. At this Congress all the leading European nations were represented, and papers were presented bearing on the subject of Inland Navigation in England, France, Belgium, Germany, Austria, Italy, Holland, Russia and America.

The importance of maintaining and improving the inland water lines was very strongly urged, and figures were presented showing an increase of canal traffic almost everywhere, in spite of the competition of the railroads. The subject which is now engaging the attention of canal engineers everywhere seems to be some improved method of traction, and interesting statistics were presented and accounts given on experiments made in this direction.

THE *Indian Engineer* has received from a correspondent a photograph of an old gun which is now lying in the jungle near the town of Bishenpoor in Bengal. Its history is not known, but it is believed to antedate the English occupation of the country. The bore of this gun is 11¼ in.; its length, 11 ft. 9 in.; the outside diameter at the muzzle, 19 in., and at the touch-hole, 29 in. It will probably weigh over six tons. It is in perfect condition except the natural wear from rust, etc. The point of the description is, that the gun is made of wrought iron *in coils*—which is perhaps another verification of the wise man's assertion that there is nothing new under the sun.

JUDGING from the reports of their proceedings, the general drift of opinion in the local engineering societies seems to be in favor of a limited or federal union with the American Society, but opposed to any organic union which will deprive them of their independence or make them simply chapters or branches of the central association. Most of them were to have representatives at the annual meeting of the American Society, but the conference then held was without any results.

Some form of union or alliance seems very desirable, and if an arrangement can be made which will secure cooperation and close friendly relations, it is by no means improbable that it will be found to work so well as to lead to a desire for still closer relations hereafter.

THE new steamer *Majestic* of the White Star Line is one of the first large ocean steamers to be completely lighted by electricity. She is provided with two separate dynamos placed in different compartments, so that the facilities for lighting are not likely to be cut off. The electric light wires extend to every part of the ship, and there are in all about 1,200 incandescent lamps of 16 candle power.

ENGLISH AND AMERICAN LOCOMOTIVES.

THE *Engineer* of September 5 contains another controversial article on the relative merits of British and Yankee locomotives, in which the writer says that he has derived amusement in endeavoring to reconcile some of the admissions made by his adversary—the editor of *Engineering News*—in one article with his endeavors to put them in another light in succeeding articles. If that sort of perplexity affords amusement to our Anglican contemporary there is probably an unlimited amount of it in store, should the discussion with the American purveyor of engineering news be continued. Thus far the dispute has not been very edifying, but it has been entertaining, and has been remarkable chiefly for statements of facts which are doubtful or not so.

The *Engineer*, in its last article, says: "The whole discussion turns on whether a locomotive boiler has to generate more steam in a given time in America than in England," and then makes the statement that "careful experiment has shown that an average performance (of English locomotives) is 500 lbs. of steam per square foot of grate per hour."

Here is a chance for the editor of the *News*. When the *Engineer* asks him to rise and "explain precisely in what way and how the American engine is a better all-round machine than ours;" or when the British disputant suggests that its American adversary "should take boilers first, and the whole practice of making steam, and the method of firing with bituminous or semi-bituminous coal, comparing English and American methods together, pointing out the defects of the former and the advantages of the latter," the questions at issue are more or less indefinite. Even when the *Engineer* says that American locomotives

do not evaporate more than from 5 to 7 lbs. of water per pound of coal, whereas English locomotives evaporate from 7 to 10 lbs., the question at issue is still vague because nothing is determined about the quality of coal, loads hauled, speeds, or size and weight of engine and boiler. But when the writer says that an *average* performance of an English locomotive boiler is the generation of 500 lbs. of steam per square foot of grate per hour, he exposes his abdomen. But the editor of *Engineering News* is a serious-minded person, and he may inquire what his transatlantic opponent means by "*average* performance." If it means that all the locomotives on an English railroad evaporate on an average 500 lbs. of water, while in service, it cannot be true. If it means that *some* of the locomotives average that amount of evaporation *while running*, then that performance is considerably below what many American locomotives are doing. We may take the figures we gave last month of the performance of locomotives on the Grand Trunk Railway. The average evaporation reported then was 7.35 lbs. of water per pound of coal. The average consumption of coal was 121.6 lbs. per square foot of grate per hour. Consequently, 893.7 lbs. of water were evaporated per hour per square foot of grate.

During last March, April and May a careful record was kept of the performance of a passenger locomotive on the Hudson River Railroad during 66 runs between New York and Albany, a distance of 143 miles. This road, as most of our American readers will know, is nearly level over its whole length, so that heavier trains can be drawn than on most other roads. The steepest grade is one of 26 ft. per mile, which is about a mile long.

The locomotive was of the American type—that is, with four wheels coupled and a four-wheeled truck, with 18 × 24-in. cylinders and 70-in. driving-wheels which carried a load of 60,500 lbs. The grate was 72 × 35⅝ in. = 17.68 square feet of area. The trains consisted of 6, 7, 8 and 9 cars. The weights were as follows:

Engine	94,500 lbs.
Tender (average)	44,000 "
Buffet Car	79,000 "
Sleeping Car	83,000 "
Compartment Car	94,500 "
Sleeping Car (16 sections)	95,000 "
Dining Car	80,000 "
Drawing-Room Car	71,000 "
Weight of 6-car train	641,000 "
Sleeping Car	63,000 "
Weight of 7-car train	704,000 "
Sleeping Car	63,000 "
Weight of 8-car train	767,000 "
Sleeping Car	63,000 "
Weight of 9-car train	830,000 "

There were 36 trains with 6 cars, 19 with 7, 11 with 8 and 1 with 9 cars.

The average consumption of coal for the 66 runs was 49.46 lbs. per train mile, and the average running speed 42.77 miles per hour—consequently the average consumption of coal was 119.6 lbs. per square foot of grate per hour. The coal used on the Hudson River Railroad is of poor quality, which, taken with the heavy loads hauled made the rate of evaporation only 6.18 lbs. of water per pound of coal. Consequently, the average evaporation for the 66 runs of 143 miles each, or a total of 9,438 miles, *was 739.12 lbs. of water per square foot of grate per hour*. The highest average evaporation for one trip was 7.80 lbs. of water per pound of coal, and the lowest 5.38. The highest average speed was 47.93 miles per hour, and the lowest 37.3. With the nine-car train, the engine evaporated an average of 868.29 *lbs. of water per square foot of grate per hour*. To show the influence of load on the rate of evaporation an experiment was made with an engine and tender which was run from New York to Albany without a train. It consumed 18.06 lbs. of coal per mile, or more than a third as much as was burned hauling the heavy trains, and *it evaporated* 9.19 *lbs. of water per pound of coal.*

Or, take the performance on the Baltimore & Ohio Railroad reported in our August number. In the experiments which were made the quantity of water evaporated per lb. of coal was not given. If it was as great as the rate of evaporation in the Grand Trunk experiments—and it probably was at least equal to that, as the coal used on the Baltimore & Ohio road is of excellent quality—the engine would have evaporated 1,423.7 lbs. of water per square foot of grate per hour, or nearly *three times* what the *Engineer* says is the *average* performance of English locomotives. What was done on the mountain grade of the Baltimore & Ohio road is not given as *average*, but as *maximum* performance. It takes just about an hour for trains to run up the 17-mile grade from Piedmont to Altamont, and probably that rate of combustion and evaporation is equalled nearly every day on that part of the road. So far as the questions at issue are concerned, the important point is the *maximum* capabilities of the engines. On nearly all our roads the locomotives probably maintain a rate of evaporation as high as that reported on the Baltimore & Ohio line for short periods of time. If they are not able to do this, in railroad vernacular, they will "stick fast," and fail utterly.

Our English contemporary says: "Our locomotives, both passenger and goods, are worked as hard as they can be worked." Now, if when they are so worked they can evaporate only an average of 500 lbs. of water per square foot of grate, they are obviously inferior to Amercian engines, which evaporate nearly twice as much, and on a pinch can convert nearly three times as much water into steam as the English engines do.

The *Engineer* asks: "What is the average performance of an American boiler?" We ask what is the maximum performance of an English boiler? If it is as much below that of American boilers as the average performance is below the average here, the English engine is much inferior to the American machine for the traffic of this and of other countries. In fact, if the English engine is what its advocate says it is, it is totally incapable of doing our work.

We have pointed out that the quantity of water evaporated per pound of coal depends very much on the rate of evaporation. If the boiler is forced to its utmost, the rate will be lower than it will be if the combustion is slower. Now, is it economical to increase the coal consumption in proportion to the water evaporated, in order to haul heavier trains?

Without going into elaborate or confusing figures, it may be stated as a general proposition that, when coal is cheap—that is, when the price does not exceed $1.75 per ton—the cost of train service, including the engineer, fireman, conductor and brakeman, exceeds that of fuel; therefore, if we make our engines do ten per cent. more work, we save more in train service than we would gain if we pulled ten per cent. less train and burned ten per cent. less coal. Besides train and engine service there are other

expenses which are lessened, such as interest on the additional equipment which would be needed if it did less work, including shops, care while not in service, etc. The purpose of a locomotive is to do work, and its efficiency is measured by its capacity for hauling trains, and of keeping in service as many days and running as many miles in a year as possible.

The *Engineer* says that the discussion thus far shows (1) that American coal is inferior to English coal, and (2) American firemen are not equal to their English brethren. The only reply one can make to this is, perhaps: Some is, or are—whichever is grammatical—and some is or are not. The character of American coals and firemen differ very much from each other, so that it does not seem worth while to make a general comparison, but probably if an English fireman should undertake to fire a consolidation or express engine while running up the grade west of Piedmont on the Baltimore & Ohio, or Altoona, on the Pennsylvania Railroad, he would get an experience he never had before.

Further, our contemporary summarizes by saying that the discussion shows that it costs more for fuel to haul heavy trains at slow speeds than would the haulage of lighter trains at higher speeds. Our assertion is that, while it may cost more for fuel, the total cost is less, and that is the important consideration with a railroad company.

Lastly, the writer in the *Engineer* concludes what he chooses to call the "defects" of the American locomotive "are the result of the conditions under which it is worked, not of defects in design or construction, or in want of adaptability to the work it has to perform." It is not easy to understand just what that means. If it is intended to say that American locomotives have been designed and constructed to do the work which they are intended to do, it is undoubtedly true, and if the converse proposition is asserted, that English locomotives are not designed or constructed so as to be capable of doing as much work as American locomotives, it would also probably be true. If, as the *Engineer* says, their locomotives, both passenger and goods, are worked as hard as they can be worked, and if, when they are thus worked their average production of steam does not exceed 500 lbs. per square foot of grate per hour, then it is plain from the data we have quoted that the British iron-horse has not as much bottom as his American congener.

Mire is not as common in London or Glasgow roads as it unfortunately is on some American streets, but if such obstruction to travel does exist there, it is doubtful whether a brewer in either of those cities would find a horse which could not pull his beer-wagon out of a "mud-hole" as valuable as one which could, even though the latter should consume more oats than the former.

But the question of the relative economy of feed of the two breeds of iron-horses, as stated by our contemporary, is not conceded. The difficulty is to make comparisons of the performance of engines under like conditions. To make fair comparisons, the weight and dimensions of engines and trains, the speeds and grades and other circumstances must be known. If our contemporary would give us some reports of carefully conducted experiments, it would throw some light on the subject. But why not adopt the suggestion made in our last number—let the *Engineer* and *Engineering News* each submit a design of locomotive to their readers for comparison and criticism. It will then be their readers' turn to be amused.

TWO VALUABLE WATERWAYS.

WHILE in many parts of the country there has been a disposition to abandon the artificial and even the natural waterways, and to allow them to be superseded by the railroads—a disposition much to be regretted for many reasons—a notable exception is to be found in the two canals which connect Hampton Roads with the extensive system of sounds and rivers of Eastern Carolina.

The older of these is the Dismal Swamp Canal, which extends from the Elizabeth River south of Norfolk to the Pasquotank River in North Carolina, and which is one of the oldest artificial waterways in the country. Chartered first in 1785, its seven locks, 100 × 18 ft. in size, were considered engineering feats in their day, and are still in constant use.

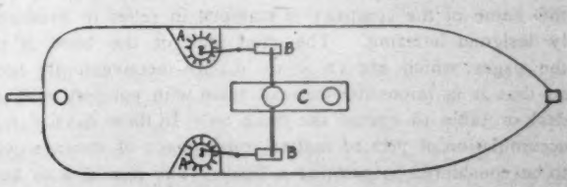
The other, the Albemarle & Chesapeake Canal, is shorter, but of larger section. It extends from the Elizabeth River to the North Landing River and has the advantage of the older work not only in size, but in the fact that it has but a single lock—240 × 95 ft. in size—and that a tidal lock, which has to be closed only at certain stages of water and in certain directions of the wind.

To equalize the conditions somewhat, the Dismal Swamp Canal Company has recently undertaken improvements which will much increase its capacity. These include an enlargement of section and the cutting down of the summit level, so as to dispense with several of the locks, and have really been made necessary by the increasing traffic.

The commercial importance of these canals can be seen from the fact that they brought to Norfolk last year 87 per cent. of the logs which supply the great lumber mills of that city, a very large proportion of the other forest products reaching the port, a considerable part of the corn, rice and naval stores, besides carrying a large traffic in merchandise southward bound.

Besides their commercial importance, these canals would be of great strategic value in case of war. A reference to the map will show how extended their water connections are and how much farther still they might be made to reach. It is to be hoped that before long improvement and extensions will be undertaken which will give, at a comparatively small outlay, an inland waterway from New York Bay to Florida, which might be of almost inestimable value in time of war, and which is sure to be commercially worth much more than its cost.

In this connection it may be of interest to note that a very early attempt at steam navigation on canals in this country was made on the Dismal Swamp Canal. The boat and its machinery were designed by Mr. Harris and by Lieutenant W. W. Hunter, of the United States Navy,



about 1840, and were for a time operated by Commodore Marshall Parks, who is still a resident of Norfolk. The boat is shown in the accompanying diagram, which is prepared from a sketch made by Mr. Parks. There were two wheels placed horizontally in semi-circular recesses cut in the sides of the boat; these wheels were simply drums

having paddles on their circumferences and driven by engines attached directly to the upper end of the vertical shafts. In the sketch *A A* are the wheels, *B B* the engines and *C* the boiler.

This boat was run for a considerable time, and was at one time taken up as far as New York. She was not altogether successful, however, and no more of the same pattern were built.

NEW PUBLICATIONS.

ELECTRO-CHEMICAL ANALYSIS: BY EDGAR F. SMITH, PROFESSOR OF ANALYTICAL CHEMISTRY, UNIVERSITY OF PENNSYLVANIA. Philadelphia; P. Blakiston, Son & Company (116 pages, 25 illustrations; price, $1).

This book is intended for students of analytical chemistry who wish to become acquainted with the methods of quantitative analysis by electrolysis; a class which is continually increasing in number as those methods acquire greater importance and come more generally into use.

The plan adopted by the Author has been to outline briefly the action of the electrical current on the different acids and salts; the various sources of electrical energy; its control and management; the history of the introduction of the current into chemical analysis. This introduction is followed by sections on determination and separation of metals and the oxidations possible by means of the electric agent. The section on each metal is accompanied by references to the history of that metal.

The methods given preference have been selected from all sources after long experience, and after tests have shown them to be reliable. The book has evidently been prepared with great care, and must prove a valuable assistant both to the student and the working chemist.

THE HALL SIGNAL COMPANY: ILLUSTRATED CATALOGUE. New York; issued by the Company.

This Company has issued a new book which describes their system of signals very completely. The titles to the different sections will give an idea of the contents. These are Block Signaling, Automatic Block Signaling, Form and Color Signals, Semaphores and Disks, Distant Signals, Trains Breaking in Two, Track Circuit Signals, Objections to Permissive Blocking, Mechanical Construction, Description of Instruments, Block Signal Circuits, Signals for Permissive Blocking, Electric Interlocking, Single-Track Block Signaling, Electric Interlocking Instrument, Principles of Electric Interlocking, Applications of Electric Interlocking, Automatic Signals for Highway Crossings, Audible Highway Crossing Signals, and Highway Crossing Gate Signals. These subjects are all treated in a very clear and comprehensive way. The book is very elaborately illustrated with wood engravings by Bartlet & Company, is printed in large, clear type, and on excellent paper. The cover is made of paper which looks like sheet iron, on which the name of the company is stamped in relief in handsomely designed lettering. The chief fault of the book is that the pages, which are 12 × 17 in., are inconveniently large, so that it is impossible to read them with comfort without a desk or table to spread the book on. In these days of rapid accumulation of printed matter convenience of stowage ought to be considered in printing a book. The puzzle is to know what to do with the copy sent us, as it will not go on the shelves of a bookcase, and is too thick to be stored with drawings. Most of the engravings could have been printed on a page half as large, and those which are too big might have been reduced in scale and not have lost materially in clearness. Excepting in its size the volume is an admirable example of a descriptive catalogue, and an illustration of the fact, to which attention has been repeatedly called, that much of the best technical literature is now to be found in trade catalogues.

TESTS OF A COMPOUND LOCOMOTIVE: BY GEORGE H. BARRUS, M.E. Philadelphia.

A pamphlet of 55 pages has recently been issued by the Baldwin Locomotive Works, containing a report of Mr. Barrus, who was employed by that Company to make a series of tests of the compound locomotive built in those works, and which has been at work on the Baltimore & Ohio Railroad.

The main and most important fact brought out in these experiments was that, in two runs from Philadelphia to Washington and return, a distance of 266 miles, one of them by the compound locomotive, and the other by an ordinary engine of substantially the same design and dimensions, excepting the cylinders, the compound engine burned 14.9 per cent. less coal than the ordinary engine. Assuming that this truly represents the economy of the compound engine over the simple one, is it sufficient to warrant the use of the former type of locomotive instead of the latter? If coal costs from $1 to $1.50 per ton, a locomotive will burn from $1,500 to $2,500 worth in a year. Calling the saving by the use of compound engines 15 per cent. it would amount to from $225 to $375 per year. As an offset to this there would be the interest on the extra cost of the compound, which is about $500. Ten per cent., which any prudent business man would charge on this, would be $50, so that the saving will be reduced to from $175 to $325.

Another important consideration in this connection is the endurance of compound locomotives—that is, can you get as many days' or miles' service in a year out of a compound engine with four cylinders and some additional complication in the valve-gear and steam-pipes as a simple engine will give? Laying up a locomotive when it is badly needed is very expensive and often results in serious loss to a railroad company. Will the economy stated compensate for the risk of a loss of service, to say nothing of some additional cost of repairs?

But even the economy reported seems to be doubtful. The only comparison of the performance of the two engines in the report before us, which it seems possible to make, is that of the two runs with the Washington limited express. The curious fact appears in this that the boiler of the compound engine evaporated 6.06 lbs. of coal per pound of water, while the simple engine evaporated only 5.37 lbs. It is also reported that the compound consumed 84,506 lbs. of water in making the round trip, and the other engine consumed 88,040 lbs. Obviously, then, it took 88,040 lbs. of steam to do the work in the simple engine that was done by 84,506 lbs. in the compound. If the boiler of the simple engine had generated steam as economically as that of the compound—that is, if it had evaporated 6.06 lbs. of water per pound of coal instead of on'y 5.37 lbs., then the simple engine would have consumed only 14,528 lbs. of coal instead of 16,389 lbs., the actual consumption. As the compound engine burned 13,942 lbs. the difference in its favor would then have been only 4¼ per cent. In other words, the economy of the compound, from the report before us, seems to be due more to the boiler than to the engine.

The data regarding the working of the two engines are given in much detail in the report, and the conclusion is stated that "the effect of the reciprocating parts, although weighing more than those of the simple engine, appeared to be inappreciable, and judging from the manner in which the new engine operated during the progress of the tests, it meets all the mechanical requirements demanded by a successful locomotive."

POOR'S HAND-BOOK OF INVESTMENT SECURITIES: A SUPPLEMENT TO POOR'S MANUAL OF RAILROADS; JULY, 1890. New York; H. V. & H. W. Poor.

This book includes the tables heretofore published in *Poor's*

Manual, with some additions; its nature can best be indicated by a brief statement of its contents. These include tables showing the coupons on bonds which become due each month in the year, with the places of payment; usual dates of dividends, times of holding annual meetings, and places of stock registry of all leading railroad companies; dividends paid by railroad companies from 1886 to 1889, inclusive, and also from January to July, 1890; ranges of active stocks and bonds on the New York, Boston, Philadelphia, and Baltimore exchanges from 1886 to 1889, inclusive, with supplemental tables showing the ranges of prices from 1878 to 1885; list of bonds maturing in the 10 years 1891–1900; list of leading railroad companies, with location of their general and transfer offices; statement of all securities listed on the New York Stock Exchange.

This will give a very fair idea of the contents of the book, and will indicate its value to banks, bankers, brokers, and, indeed, to all who are interested in railroad securities either as dealers or investors, and this certainly includes a very large class of the community. The book has been carefully prepared by the publishers of the *Manual*, who have exceptional facilities for the work.

POCKET DIRECTORY FOR 1890: A COMPLETE LIST OF NEWSPAPERS, MAGAZINES AND PERIODICALS IN THE UNITED STATES AND CANADA. Chicago; Lord & Thomas.

This little book seems to be what the publishers have designed to make it—a complete list of the periodicals of the United States and Canada, with some facts, briefly stated, as to their character, circulation, etc. In a newspaper office it is almost indispensable, and to advertisers of all classes it must be extremely useful.

HANDY LISTS OF TECHNICAL LITERATURE: PART III, ENGINEERING AND MECHANICS: COMPILED BY H. E. HAFERKORN AND PAUL HEISE. Milwaukee, Wis.; Heise & Haferkorn (price, paper, $2.50; cloth, $2.75).

This is intended to be a list of all books in the English language on subjects connected with engineering and mechanics, published since 1880, and is supplemented by a list of periodicals treating the same class of subjects.

The preparation of such a work is no light task, and it is impossible to say how completely it has been done until the book has been in use for some time. A short examination, however, indicates thorough and careful work, and the *List* will be of great service to the engineer, the student, and the editor as a book of reference and constant desk companion.

The extent of the work will be apparent, when it is stated that it contains the titles of nearly 2,200 books and papers, with references to their authors and publishers. It is brought up to the latest date, including many books published in the present year.

BOOKS RECEIVED.

REPORT OF TESTS OF A COMPOUND LOCOMOTIVE (S. M. VAUCLAIN'S PATENT) BUILT BY THE BALDWIN LOCOMOTIVE WORKS AND IN SERVICE ON THE BALTIMORE & OHIO RAILROAD: BY GEORGE H. BARRUS, M.E. Philadelphia; published for Burnham, Parry, Williams & Company.

SELECTED PAPERS OF THE INSTITUTION OF CIVIL ENGINEERS. London, England; published for the Institution. The papers last received include the following: Coasts and Rivers of Yesso, by C. S. Meik; Artesian Wells in South Lincolnshire, by John Charles Gill; Keswick Water-power Electric Light Station, by W. P. J. Fawcus and E. W. Cowan; Welding by Electricity, by Sir Frederick Bramwell; Wire Ropes, by Andrew S. Biggart; Probable Errors of Surveying by Vertical Angles, by Wilfrid Airy; the Screw Propeller, by Sydney Walker Barnaby.

A second installment of these papers includes the following: Deflection of Spiral Springs, by Alfred E. Young; Distributing Triangulation Errors, by A. E. Wackvill; Barytes and Umber Mines and Refining Mills, by Percy L. Addison; the West Hallington Reservoir, by C. G. Henzell; Applications of Electricity in Engineering Workshops, by Charles F. Jenkin; Railway Stations and Yards, by Richard M. Parkinson; the Calliope Graving Dock at Auckland, N. Z., by J. H. Swainson; Abstracts of Papers in Foreign Transactions and Periodicals.

PROTOCOLS OF PROCEEDINGS OF THE INTERNATIONAL MARINE CONFERENCE, HELD IN WASHINGTON, D.C., UNITED STATES OF AMERICA, OCTOBER 16–DECEMBER 31, 1889: VOLUMES I, II, III. Washington; Government Printing Office.

LIST OF MERCHANT VESSELS OF THE UNITED STATES: PREPARED BY THE BUREAU OF NAVIGATION, TREASURY DEPARTMENT. Washington; Government Printing Office.

HERZOGLICHE TECHNISCHE HOCHSCHULE CAROLO-WILHELMINA ZU BRAUNSCHWEIG: PROGRAMME FOR THE SCHOOL YEAR 1890–91. Brunswick, Germany; issued by the School.

PRACTICAL TREATISE ON INJECTORS AS FEEDERS OF STEAM BOILERS: FOR THE USE OF MASTER MECHANICS AND ENGINEERS IN CHARGE OF LOCOMOTIVE, MARINE AND STATIONARY BOILERS: BY GEORGE H. NISSENSON, ENGINEER. New York; published by the Author (74 pages, illustrated; price, 50 cents).

THE SEWERAGE OF COLUMBUS, O.: ADDRESS BY COLONEL GEORGE E. WARING, JR., AT THE BOARD OF TRADE AUDITORIUM, JUNE 23, 1890; WITH DISCUSSION FOLLOWING. Columbus, O.

WESTON STANDARD VOLTMETERS AND AMMETERS FOR DIRECT CIRCUIT CURRENTS: ILLUSTRATED CATALOGUE. Newark, N. J.; the Weston Electrical Instrument Company.

REPORTS FROM THE CONSULS OF THE UNITED STATES; NO. 117, JUNE, 1890. PREPARED BY THE BUREAU OF STATISTICS, DEPARTMENT OF STATE. Washington; Government Printing Office.

THE PRESERVATION OF IRON STRUCTURES FROM RUST: NATURE AND COMPOSITION OF BAR AND CAST IRON AND THEIR BEHAVIOR UNDER THE INFLUENCE OF THE ATMOSPHERE, MOISTURE, ACIDS, ETC. Brooklyn, N. Y.; issued by J. H. Tiemann.

ABOUT BOOKS AND PERIODICALS.

IN the JOURNAL of the Military Service Institution for September, Captain Mills's notes on India, China and Japan are continued; there are articles on Infantry Fire Tactics, by Lieutenant Howard; Recent Japanese Manœuvers, by General Abbot; Light Artillery Target Practice, by Lieutenant Hawthorne; Infantry Ammunition on Battle Field, by Lieutenant Beckurts; Diet of the Soldier, by Surgeon Waters. The series of historical sketches of the Army is continued by a History of the Fourth Regiment of Artillery, written by Lieutenant A. B. Dyer.

Among the many magazines of the day one, at least, is free from sensationalism and doubtful fiction. OUTING unweariedly preaches the gospel of wholesome living, and the numerous bright and breezy articles in its September number treat of outdoor sports and games, manly—and womanly—exercise and similar topics in a way that makes it most interesting reading.

The latest quarterly number of the PROCEEDINGS of the United States Naval Institute contains papers on Navy Boats, by Ensign A. A. Ackerman; Desertion, by Lieutenant A. McCrackin; the Howell Automobile Torpedo, by E. W. Very; and Admiral S. B. Luce's paper on Naval Training, with the

extended discussion on the same. There are also some interesting professional notes of minor importance.

The August number of the JOURNAL of the American Society of Naval Engineers has papers on the Double-screw Ferry-boat *Bergen*, by Chief Engineer Isherwood, U.S.N.; on Boiler Tubes, by Passed Assistant Engineer R. T. Hall; on Continuous Current Dynamos, by Professor Jamieson. The discussions on Speed Trials of Fast Ships and on Tubulous Boilers are continued, the latter being chiefly made up of an account of the Belleville boiler, by Mr. Miers Coryell, who ably advocates the claims of that boiler.

A new monthly, the field of which is indicated by its name—PAVING AND MUNICIPAL ENGINEERING—has been started in Indianapolis, with Mr. William Fortune as Editor. The current issue has several very interesting articles, and there are some contributions of note on the list. The field is one that has not been filled properly by existing journals, perhaps, and our new contemporary, we hope, will meet with deserved success.

In BELFORD'S MAGAZINE for September serious economic questions find room, as well as the usual quota of fiction and lighter matters, and there are a number of articles that will stand a careful reading. An interesting feature of this magazine are the short articles on current topics, some of which are excellent specimens of condensed argument.

A new venture is the AMERICAN SHIPBUILDER, of New York, a weekly paper edited by Messrs. G. Foster Howell and David L. Bradley, and intended for shipbuilders, shipowners, marine architects, and engineers. The first number has eight pages and contains an excellent variety of news and technical articles, with an illustrated description of the new lighthouse steamer *Azalia*.

In SCRIBNER'S MAGAZINE for September Professor N. S. Shaler has the first paper of a series on Nature and Man in America. Mr. Russell Sturgis's recent paper on the City House is supplemented by one on the Country House by Donald G. Mitchell. Life on a modern cruiser is described and illustrated by Mr. Zogbaum in a very entertaining article, and Mr. Thomas Stevens gives a general description of African River and Lake Systems.

Municipal Government; Taxes; the Race Question and some of the difficulties now besetting the Dominion of Canada, including the railroad question, are among the subjects discussed in the ARENA for September, while less material matters have their full share of space for the month.

AROUND HAMPTON ROADS.

THE ancient seaport city of Norfolk has in recent years shown signs of very substantial progress, and to a visitor the improvement is very marked, the number of substantial buildings and new wharves indicating the increase of the city's business. Several causes have contributed to this growth, among which may be mentioned the extension of the railroad systems which find their terminus there; the building of new railroads; the excellent water connections of the city; the growth of the surrounding country, and the improvement of the harbor, the channel now having a depth of 25 ft. at low tide up to the city wharves and the Navy Yard.

The extensions of the Norfolk & Western Railroad have made it an important coal and mineral line, as well as a cotton carrier. To serve the coal traffic the road has built a very fine pier at Lambert's Point, a little below the city, where last year over 1,000,000 tons were delivered, and growing business has made necessary recently the erection of new piers for merchandise and general freight at the same point. The new railroads recently completed to Norfolk include the Atlantic & Danville, running eastward to Danville, Va., and the Norfolk & Carolina, which runs southward into the lumber district, and which is still being extended. The Virginia Beach Railroad not only serves for pleasure travel, but also brings in a considerable local business.

Norfolk last year shipped over 500,000 bales of cotton, but although it has been popularly known chiefly as a cotton port, this is not by any means a measure of its business. The receipts of grain of various kinds and tobacco were large. The coal receipts have been mentioned above, and the port has already begun to receive a considerable amount of iron from the Southern furnaces. The shipments of vegetables and fruit from the truck farms about the city also form an important business. The chief single interest, however, is the lumber business, and several mills of very large capacity have been established for the manufacture into lumber of the logs which reach the city partly by rail, but to a great extent by canal. This business is continually growing, and its success here is secured by the fact that there is a practically inexhaustible back country to draw upon for supplies of logs, and that a very large part of this forest region can be reached by water. The growth of the timber in this section is quick, and the supplies are renewed so fast that there is no danger that the forest will be destroyed.

Apart from the lumber interests Norfolk is not yet a manufacturing city, although it presents many advantages in that respect, owing to its command of cheap supplies of coal, lumber, cotton, etc., and also to the abundant supply of labor. A commencement in this direction has been made in the establishment of a large knitting mill in the suburb of Berkeley, which is now in successful operation, and which is provided with machinery of the latest patterns; while other establishments will soon be added. Apart from the factories the chief need of Norfolk at present is additional wharf facilities. The construction of new docks on the water front has been delayed by various local causes, but arrangements are now being made to supply this want.

NEWPORT NEWS.

Newport News may be considered as practically a suburb of Norfolk, from which it is distant 12 miles by water. It is the terminus of the Chesapeake & Ohio Railroad, and considerable shipments of cotton, tobacco and grain are made from this point, but while it has advantages in the way of deep water, etc., the harbor has not the shelter which is provided at Norfolk, and the growth of the town outside of the railroad piers has been comparatively slow.

A very large manufacturing establishment has been begun here, however, by the Newport News Ship Building & Dry Dock Company, which will have, when completed, one of the largest ship-building plants in the country. A large amount of work has already been done here, and is now approaching completion. The buildings include smith shops, machine shops, plate shops, etc., and are of large size and substantially constructed of brick. A few of the tools are already in place, including eight steam hammers in the smith shop, while other tools are being received and are under construction. The steam hammers are all of Bement, Miles & Company's make, and many of the machine tools are from the same establishment. The ship yard will have eight building slips, and there is already completed a Simpson dry-dock, which is similar in plan and construction to that at the Norfolk Navy Yard, described in another column, but is larger in size, being 600 ft. long, or 100 ft. longer than that at the Navy Yard. A commencement has already been made, and two iron tugboats are under construction. The first important work, which will be begun as soon as the shops are ready, will be the building of two large steamers for the New York and New Orleans trade. These steamers will be named *El Norte* and *El Sud*, and will be sister ships, 400 ft. long, 48 ft. beam and 33 ft. depth of hold. They will be equipped with quadruple-expansion engines of large size which will be built in the shops.

A GERMAN PASSENGER STATION.

THE accompanying illustrations, from the *Deutsche Bauzeitung*, show the new passenger station in Bremen, Germany. The building faces the principal park of the city, and the general design is very graceful, harmonizing well with the surroundings. The waiting-rooms and offices are in the building at the side, while the train-house is covered by a lofty arched roof, so designed as to form an integral part of the structure. Through this train-house there pass six tracks, belonging to the lines to and from Hamburg, Osnabrück, Geestemunde, Hanover and Oldenburg.

THE NEW PASSENGER STATION AT BREMEN GERMANY.

In addition to the platform close to the office building, there are two wide platforms running the length of the train-house. These are reached by tunnels running under the tracks, but on a level with the floor of the main waiting-room, the tracks being above the street level. The platforms are reached by stairways from the tunnels.

In the ground plan, fig. 2, the six tracks and the platforms are shown, and also an additional switching track,

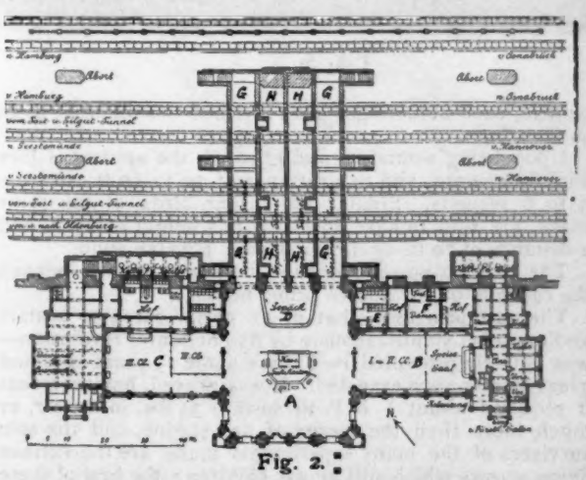


Fig. 2.

running outside the wall of the train-house. In this plan *A* is the main waiting-room; *B*, the restaurant; *C*, the third-class waiting-room; *D*, the baggage-room; *E* and *F*, the toilet-rooms; *G G* are the tunnels or passages for passengers, and *H H* those for baggage.

The train-house is 646 ft. long, 194 ft. wide and 98 ft. high in the center. The roof is carried on iron arch girders.

The principal feature in the station building proper is the main hall or waiting-room, which is 105×120 ft. in size, and 78 ft. high to the center of the arched roof. A small view of the interior of this fine hall is shown in fig. 3. The ticket office detracts somewhat from the size of this hall, and the exit doors are rather too low in proportion; but the general effect is very fine.

The central pavilion and its adjoining structure on each side have no second story. The wings have each three, the upper floors being used for offices and other necessary purposes. In one of them is the royal room, with which all first-class stations in Germany must be provided, and which is very handsomely fitted up and furnished.

The main building is of Obenkirchen sandstone, with trimmings of darker stone. The roof is surmounted in front by a parapet of cut stone; the angles of the wings and the two half-towers which complete the front of the main pavilion are ornamented by groups of statuary. A small bell tower is placed in the angle between the east wing and the train-house, and carries a clock.

The arched roofs are covered with galvanized iron. The roofs over the restaurant and third-class waiting-rooms are chiefly of glass.

Fig. 3.

The station is well provided with all necessary conveniences, arranged, as is customary in Germany, separately for the different classes of passengers.

The architect of the building, who had charge of its designing and general construction, was Professor Hubert Stier, of Hanover.

AERIAL NAVIGATION.

By O. Chanute, C.E., of Chicago.

(A lecture to the students of Sibley College, Cornell University; delivered May 2, 1890.)

(*Continued from page* 397.)

PART II.—AVIATION.

Having sketched what has thus far been accomplished with, and what may be fairly expected from navigable balloons, we may next turn our attention to that other class of students who call themselves "Aviators," and who, discarding the use of a gas-bag, seek to solve the problem of flight by purely mechanical means. They point to the birds in confirmation of their views, and constitute by far the most numerous as well as the most ancient school; for, to say nothing of ancient traditions, earnest proposals have been brought forward during the last 400 years to compass flight by various mechanical contrivances.

With these students, the possibility of success has been more a matter of faith, of instinctive belief, than of sober calculation. They watched the birds, saw that they progressed through the air by mechanical action and skill, and were very much heavier, bulk for bulk, than the air which their bodies displaced (for we may dismiss with a smile the old-time assertion that birds gain levity by inflating their quills with heated air), and they hoped that man might accomplish similar results by somewhat similar means.

Impressed with these views, a number of these students have organized aeronautical societies in Great Britain, in France, and in Germany, and have for the past 20 odd years been reading papers, discussing the subject, and trying sundry experiments.

Very little practically has thus far come from these efforts, for curiously enough, and yet naturally, the first endeavors were to devise or to construct models, which have remained toys, before knowing accurately the resistances and conditions which they were to encounter in the air. In other words, the work began upon the constructive instead of the analytical features of the case, as usually happens at the outset of an invention, and while a good deal of valuable information has been gathered, no practical machine has yet resulted. Some theoretical investigations have been attempted, but unfortunately the scientists have been hopelessly at variance not only among themselves, but also, what is more important, with some of the ascertained facts.

Thus it has been so far unknown what power birds expend in overcoming the resistance of the air in their flight, or what amount of support they derive from it at various angles; and although the laws of fluid resistances laid down by Newton are known to be erroneous, they are still taught in the academies; and it was only the past summer that a new theory of flight, which may prove to be the correct one, was proposed simultaneously by two civil engineers at the Aeronautical Congress of the Paris Exposition.

Even the theory of the equilibrium of the common kite, supposed to have been invented by Archytas 400 years B.C., is still a subject of dispute, and every little while a fresh solution of its numerical reactions is proposed by a mathematician.

Possibly, in consequence of this state of uncertainty as to the laws of flight, the Aviators have been divided into three camps or sub-schools, which have looked for success from somewhat different contrivances, and who have advocated the following mechanical means:

1. The imitation of the flapping action of the wings of birds.
2. The sustaining of weight and obtaining progress simultaneously through the air by horizontal screws.
3. The sustaining of weight by fixed aeroplanes, and the obtaining progress by means of screws.

A great many experiments have been tried and a great deal of ingenuity has been expended in each of these three directions, but thus far not a machine has been able to leave the ground with its prime motor, and what measure of success has been attained can only be exhibited through toys, which give an idea of the principles involved.

The advocates of wing action hold that nature cannot err in her methods, and that success is only to be achieved by imitating her; they have therefore endeavored to devise moving surfaces which shall repeat the complicated movements of the wings of birds, so as simultaneously to sustain and propel the apparatus. The only motive power which it has thus far been found practicable to use has been the torsion of india-rubber, and with this a number of clever mechanical birds have been contrived by Mr. Brearey in England, and by MM. Penaud, Tatin, de Villeneuve and Pichancourt in France.

The latter—that of Pichancourt—dates only from last summer, and is represented by fig. 5.

It measures about 12 in. from tip to tip of wings, and weighs 385 grains, one-third of which consists in the twisted rubber strings furnishing the motive power. The necessary flexion of the wings, to obtain a propelling as well as a sustaining reaction, is produced by a triple excentric, each actuating a lever fastened to a different point in the wings.

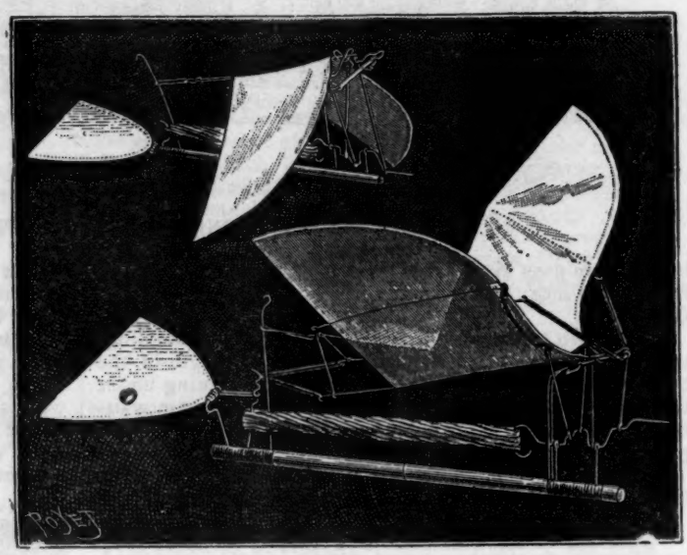


Fig. 5.

Upon being wound up and released, the apparatus flies slightly upward, and to a distance of 30 to 60 ft., in from 3 to 6 seconds. Similar but larger birds, of the same make, are said to have flown up to a height of 25 ft. and a distance of 70 ft. against a slightly adverse wind.

The relative power absorbed, however, is quite beyond the capacity of any known prime motor.

The next principle—that of an aerial screw to sustain and to propel simultaneously by its horizontal revolution—was actively promoted in France some 25 years ago, and great results were expected. It was proved, however, that it required about 1 H.P. to sustain 33 lbs. in the air, or much more than the energy of any engine, and the sole survivors of the many experiments made are the various flying screws which still amuse children; the best of these being that of Penaud, shown in fig. 6, in which two screws rotate in opposite directions and cause the apparatus to rise or to fly in a circle, according to the proportions of its various parts.

And lastly, in recent years, experiments have been made with combinations of fixed surfaces, called aeroplanes, to sustain the weight, and of rotating vertical screws to propel. Machines or models on this principle have been built by Heuson, Stringfellow and Moy in Great Britain, and by Penaud, Tatin, de Louvrié, and du Temple in

France, but thus far not one has succeeded in lifting a self-contained motor, and perhaps, after all, the best example of this class of contrivance is the artificial butterfly of M. Daudrieux, which is shown in fig. 7.

The flight of all these toys lasts but a few seconds, and

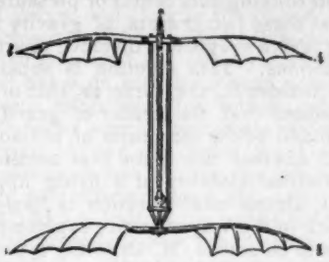


Fig. 6.

none of them carries its own motive power, while it will be found by measuring accurately the foot-pounds expended, and the weights sustained in a given time, that not one of the prime movers known is as yet sufficiently light, in proportion to its energy, to furnish the power required to maintain them in the air.

This question of motive power, the vital one in Aerial Navigation, will be discussed more particularly hereafter, but it may here be mentioned that a few observers, who have been watching birds soar without flapping their wings in southern latitudes, believe that this species of flight involves no expenditure of power whatever, save for the getting under way. This opinion has been much ridiculed, but yet it is possible that if we take into account the force of the wind, the belief of these observers that certain birds can soar indefinitely at moderate speeds without other exertion than the passive one of keeping the wings rigidly extended may not be as absurd as at first sight appears; but if man is ever to direct himself at will through the air, at satisfactory velocities, he will need power, and plenty of it; more indeed in proportion to the weight of the motor and of its supplies than he has yet been able to devise.

Meanwhile a few observers and scientists have been patiently investigating the motions which birds perform

Fig. 7.

in their flight. Among these may be mentioned the Duke of Argyle and his book, "The Reign of Law;" M. Mouillard and his "Empire de l'Air;" Dr. Petigrew and his book on "Animal Locomotion," and especially Professor Marey, who has just published a book, "Le Vol des Oiseaux," the result of 20 years' investigation, which is most interesting and valuable, but which, unfortunately, throws but little light upon the all-important questions as to the sustaining reactions to be derived from the air, and the power required for flight; the latter having remained in controversy since the days when Navier made the erroneous calculation that a flying swallow exerted one-seventeenth of a H.P., or at the rate of no less than 3,586 H.P. per ton of weight.

Of course, the first thing to ascertain is to know what are the components of air pressure upon a plane in motion at a given velocity, if inclined to the current. In other words, what proportion of the usual right angle pressure remains if the plane be tilted, and how much of this new pressure acts as a sustaining force or *lift*, while how much opposes forward progress, and may be denominated *drift*. Some interesting experiments have been made in Great Britain on this subject, and more of them in France, but they have chiefly been made with some form of rotating apparatus, and it was found not only that the results obtained with direct currents did not agree with those of rotary machines, but that the latter showed greater pressures on planes inclined at angles of 50° to 70° than on those placed at right angles to the current (a most improbable condition), so that it is now believed that the centrifugal force of the rotating vanes in some way vitiates the results, and the French have been preparing to try a new set of experiments upon artificial currents to be produced by large ventilating fans.

Things were in this condition when an International Congress of Aeronauts and Aviators was held in Paris last August. During this a number of papers were presented, and among them were two which may lead hereafter to a new and more rational theory of flight. One was by a Russian engineer, M. Drzwieki, who, starting from the best empirical formulæ he could find, had calculated the weights sustained, the surfaces required, and the power needed for aeroplanes in artificial flight at various velocities, while the second paper was a theoretical investigation of the same subject by the present lecturer.

The remarkable result about these papers was that, starting from two different standpoints—the empirical and the theoretical—they closely agreed in their conclusions; and as the paper of M. Drzwieki was the most complete and thoroughly worked out, I shall prefer to give an account of it rather than of my own.

M. Drzwieki first showed that the hitherto received idea that a bird in flapping his wings generated thereby a sufficient pressure to sustain his weight is incorrect. It has long been known that the pressures experimentally obtained by striking the air with surfaces of equal area and velocity with those of the wings of a bird, or even with the wings of a dead bird dried and mounted in an apparatus, do not generate a sustaining reaction equal to the weight of the bird; but it was dimly believed that the living bird had the skill, in some mysterious way, of obtaining from his strokes sufficient intensity of pressure to sustain his weight. M. Drzwieki says that this view is quite erroneous, and that the bird is really sustained by the vertical component of the pressure due to his speed. In other words, that the flying animal is really an aeroplane, whose body and wings in all stages of their action make a very small angle with the impinging air, and that the propelling power is chiefly derived from the rear thrust exerted by the escaping air against the outer curved extremity of the quill feathers.

Moreover, if account be taken of the forward motion, the angle which the wings present to the line of flight must be less than 6°. It is imposssible to detect this angle of incidence by the eye. The wing seems to be flapped vertically downward; or in soaring the bird seems to hold his wings and body absolutely horizontal; but in point of fact we know that there must be an angle of incidence in order to obtain a sustaining reaction.¶ This brings up the inquiry as to what that angle really is.

M. Drzwieki starts from Duchemin's empirical formula of the normal resistance which air opposes to an inclined plane moving against it, and deduces therefrom the sustaining reactions per square meter at various velocities for various angles from 20′ to 10°, and these are tabulated for ready reference. Next he calculates the horizontal components of the normal pressure for the same velocities and angles, this being the resistance to the advancement of the plane alone, and to this is added the head resistance due to the thickness necessary to secure the required

strength of the plane, or, in other words, its hull resistance, and to this again is added the probable friction of the air against the sides. These three items together give the total resistance to forward motion, and are also tabulated for ready reference.

Then, by combining these two tables and plotting the resulting curves, in order to ascertain at what angle there is a minimum of resistance to forward motion, while yet retaining a sufficiency of sustaining power, it is found that this occurs for one and the same angle at all velocities, this being 1° 50′ 45,″ and this M. Drzwieki assumes as the angle of flight.

I may here mention that these two reactions, or components of the normal pressure due to the angle of incidence and to the speed, formed the subject of the paper read by myself at the Paris Congress, and of a similar paper which I presented before the American Association for the Advancement of Science at its last meeting, and that I had reached the conclusion that the most favorable angle for soaring was between 1° and 2°.

Assuming 1° 50′ 45″ as the angle of flight, and allowing for the vertical and horizontal components of the normal pressure due to the speed at that angle, as well as for the hull resistance and friction, M. Drzwieki then gives four formulæ, supplemented by tables, which produce the following elements :

1. The weights per square meter, which can be sustained at this angle of 1° 50′ 45″ at various speeds.
2. The work done (kilogrammeters) to overcome the forward resistances under the same circumstances as above.
3. The proportion of the work done to the weight sustained.
4. The amount of surface required to sustain 1 kilogramme at various velocities.

The consequences which M. Drzwieki deduces from these formulæ and the plotting of their curves are the following :

1. An aeroplane progressing horizontally, with the angle of incidence (1° 50′ 45″) corresponding with the minimum of work, meets practically the same resistance at all speeds, so that the work done is approximately a function of the weight of the apparatus, multiplied by the velocity.
2. Aeroplanes designed for small speeds need relatively large surfaces and small weight ; these conditions he believes to be difficult of realization in practice.
3. The greater the speed, the less surface needed to support a given weight.
4. The less the surface, and therefore the greater need of speed, the greater must be the motive power.

These conclusions are believed to be approximately sound, and M. Drzwieki sustains them by showing that in flying birds the smaller is the sustaining surface in proportion to their weight, the greater is their customary speed, giving a table of the proportions of some 64 birds, which shows that the surfaces of the body and extended wings range from 7.56 sq. ft. to the pound for the bat, which flies at the rate of about 20 miles per hour, to 0.43 sq. ft. per pound for the male duck, who progresses at about 60 miles per hour. He estimates that for a speed of 90 miles per hour, the surface required will be but 0.22 sq. ft. to sustain a pound of weight.

It seems to follow as a conclusion that if aeroplanes are ever built to carry tons of weight, their proportion of surface to weight may be considerably less than those which obtain with birds, but that the speed will need to be greater than that of flying animals in order to obtain support from the air, while the motive power required will vary approximately only in the direct proportion of the weight carried. This important conclusion seems to hold out hopes that success may eventually be attained if the stability of the apparatus can be secured.

M. Drzwieki also discusses this question of stability. He shows that the transverse equilibrium can easily be maintained by a diedral upward slant of the wings of an aeroplane, arranging them like the sides of the letter V, but at a very obtuse angle, so that any tendency to tilt shall at once develop greater pressure in that direction, and thus restore equilibrium. This was pointed out as early as 1809 by Sir George Cayley, in a remarkable series of papers published in *Nicholson's Journal*, which are well worth reading.

M. Drzwieki states the law of longitudinal equilibrium to consist in placing the center of gravity of the whole apparatus vertically below the center of pressure due to the angle of flight, and he gives the rule, first formulated by Joëssel, for determining this center of pressure. He moreover states that these two centers, of gravity and of pressure, must be but a very short distance apart, in order to prevent oscillations. This solution is substantially, for flat angles of incidence, the same as that of Sir George Cayley, who states that the center of gravity must be at right angles to and below the center of pressure ; but it is to me doubtful whether this is the best solution for assuring the longitudinal stability of a flying apparatus, and this important, almost vital question is likely to prove a stumbling-block in the way of future experimenters.

Assuming it to be solved, M. Drzwieki estimates that an apparatus, built to the best possible proportions as to exposed surface and form, and sailing at an angle of 1° 50′ 45″, will require to drive it at 25 miles per hour but 5.87 H.P. per ton of its weight. This assumes the thickness of apparatus and consequent hull resistance to be but $\frac{1}{100}$ of its horizontal dimensions, while for birds it generally runs from 5 to 10 per cent. That is to say, that birds exposing a horizontal surface of say 100 sq. in. generally expose a maximum cross-section vertically of 5 to 10 sq. in., while M. Drzwieki believes this can be reduced to the proportion of 1 sq. in. per hundred for an aeroplane.

My own estimate of the power required by a common pigeon gliding at an angle of 1° with the horizon was 9.33 H.P. per ton of his weight, and 10.49 H.P. per ton at an angle of 2° for this same velocity of 25 miles per hour.

These are considerably less than the powers required to drive a balloon of moderate size at the same speed, for we have already seen that the air-ship *La France* would require 51 H.P. to attain 25 miles per hour ; or, as it weighs 2.2 tons, the motor would needs develop 23.2 H.P. per ton of the weight of the whole apparatus. For the balloon of double this size, the power required is at the rate of 10.34 H.P. per ton of apparatus. This power required would moreover increase in the case of the balloon, as the cube of the velocity, while M. Drzwieki shows that in the case of an aeroplane the power will increase only in the direct ratio of the speed, because as the velocity becomes greater the area of sustaining surfaces required becomes less, and he estimates that an aeroplane will require 10.43 H.P. per ton to go 44.72 miles per hour, and 20.62 H.P. per ton of its weight at 89.44 miles per hour.

(TO BE CONTINUED.)

ELECTRIC TRANSMISSION OF POWER.

(Condensed from *Le Genie Civil.*)

DURING the year just closed the paper-mill at Moutier, in the Department of l'Isere, has been the scene of an important series of transformations, the object of which was to replace the existing motive power by electric transmission. This was partly favored by circumstances, and has been a complete success. To describe properly the plan, it will be necessary to give some little description of the neighborhood.

The village of Moutier is situated about 500 m. (1,640 ft.) from Domene, and 11 km. (6.84 miles) from Grenoble. The track of the railroad line from Chambery to Valence, which runs the whole length of the Gresivauban Valley, passes close to the factory, not far from the station of Domene.

Below Moutier the river Isere receives the waters of a small stream called the Domenon, which issues from a mountain which overlooks the peak of Bellebonne, at a height of 2,980 m. (9,774.4 ft.) above the sea level. If we follow this stream from its mouth above the village of

Domene, we enter a narrow gorge, the rocky walls of which rise at different points 200 m. (656 ft.) above the current. On the banks of this stream stand some paper-mills which are run by water power, the power being derived from a fall 180 m. (590.4 ft.) in height at some distance above, from which it is necessary to carry the water about 2 km. through a canal to reach the turbine wheels.

Above this gorge, and close to the stream, there is a little hamlet, known as Eaux-de-Revel, which is 5 km. from Domene by the course of the stream. This is at the foot of a fall which has been used for motive power, and at this point have been established the turbine wheels and the generating dynamo which transforms water power into electric energy. Above this point the Domenon, for a considerable distance, has an average fall of 1 in 10, and at the bridge of Cornets, where the water is taken, the level is 70 m. (229.6 ft.) above the power-house, to which it is conveyed by a wrought-iron pipe having a total length of 700 m. (2,296 ft.). It was necessary to give this pipe a foundation sufficiently solid to prevent it from being disturbed by the frequent floods. The present arrangement is only temporary, and when more power is needed water will be taken from a point which will give a total fall of 130 m. (426.4 ft.) to the power-house. Above this point there are two small hamlets and several houses, and upon the right bank there comes in an important tributary stream, the Dhuys, which is fed by a considerable rocky water-shed, and which brings to the Domenon a supply without which the water in winter would be too low to supply the necessary power. A little further up, upon the opposite bank, there is also a small stream which flows from Lake Robert, and which is fed somewhat irregularly

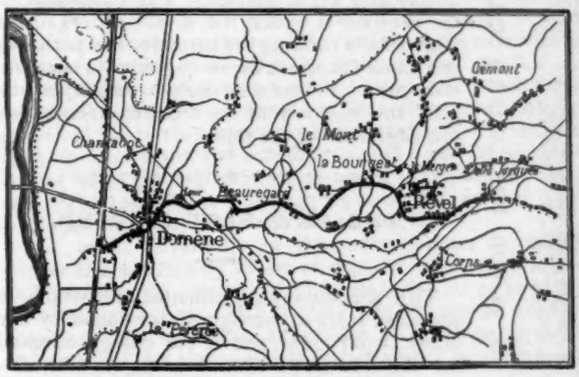


Fig. 1.

by the melting snows from the Petite Bodene. Above this point the mountain rises abruptly, and there are several small falls ending in the Cascade of l'Oursiere, where at a single leap the stream falls 60 m. (196.8 ft.), and in the spring the flow of the stream is from 13 to 15 cubic meters (458 to 530 cub ft.) per second. Above this cascade the forest ceases and the mountain is rocky and desolate ; and here are found the sources of the stream in several little lakes where are gathered the waters derived from the melting of the snows, and of a glacier which is found on the southwestern slope of the mountain.

At the power-house, which has been named " La Force," the generating dynamo, which is driven by a turbine with a horizontal shaft, is joined by two wires carried on poles, which convey the power to the receiver at Moutier from La Force. The line runs directly out some distance from the stream to the village of Revel, whence it follows the road well known to tourists who ascend the mountain. The posts are set at the side of the road until they reach the gorge before referred to, when they leave the road and descend almost in a direct line with an inclination averaging 60°, thus avoiding the numerous windings of the road.

The general conditions of the working of this transmission are as follows : The generating dynamo has a maximum speed of 240 revolutions per minute and a maximum power of 300 H.P. The receiver has a maximum speed of 300 revolutions per minute and a maximum power of 200 H.P. The transmitting line is 5 km. (3.11 miles) in length. The electro-motive power has a maximum of 2,850 volts and a maximum intensity of 70 ampères. The electric result obtained, calculated after deducting all re-

Fig. 2.

sistances, is 83 per cent. of the total power, while the average mechanical result is 65 per cent.

Since it has been put in operation this transmission has run steadily day and night. Although the running of the machinery does not present any special difficulty, it is worthy of note that it is managed entirely by the same persons who formerly ran the machinery with steam power, but who, although they had no previous acquaintance with the management of dynamos or electric motors, have had no difficulty in operating these.

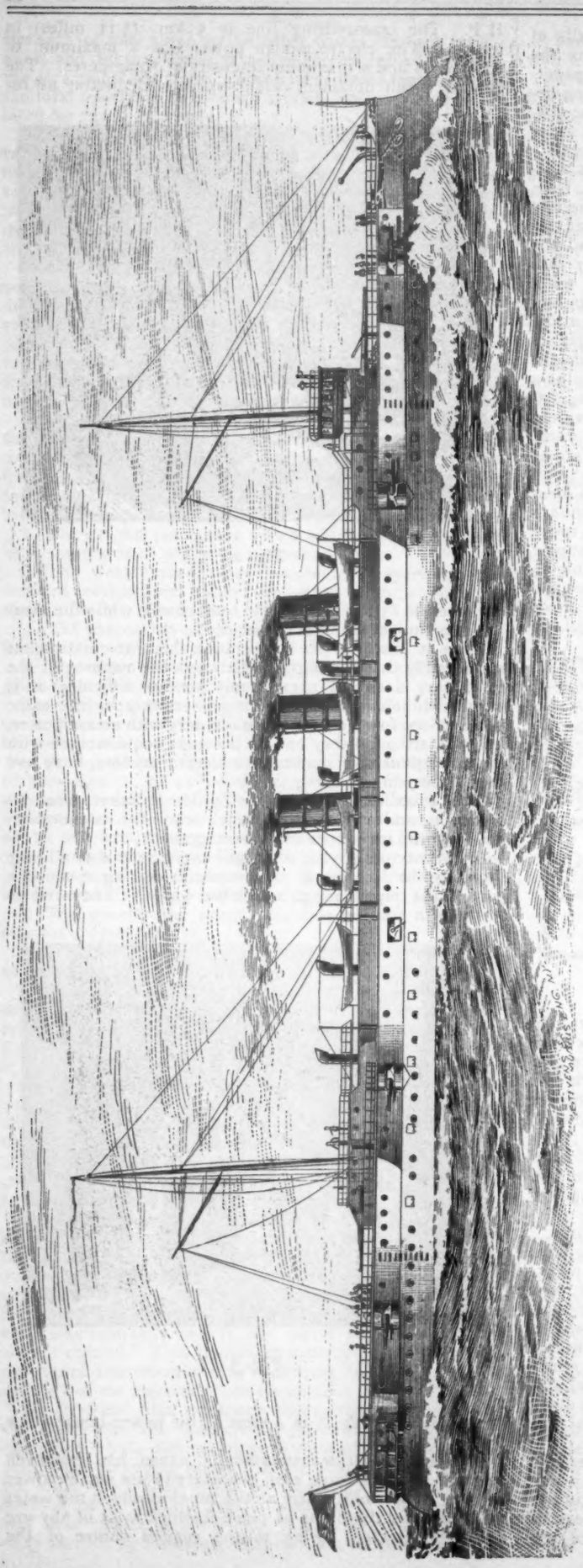
This installation was made by M. Hillairet, who designed it, and who deserves much credit for its completeness and the excellence of its arrangement.

In the accompanying illustrations, fig. 1 is a small map showing the location of the transmission ; fig. 2 shows a part of the pipe through which the water is conveyed to

Fig. 3.

the turbine, and fig. 3 is a view of the power-house at La Force.

If this plan for transmission of power had not been adopted, it would have been necessary to use steam power for the paper-mill, since at the point at which the water could be used there was no place at which mills of any size could be erected, owing to the rugged nature of the



CRUISER NO. 12 FOR THE UNITED STATES NAVY.

ground; and moreover it would have been impossible to convey material to or from the mills, should they be located there, or to build roads over which heavy loads could be hauled. The power was there, but could be made available only by this method of transmission. When this installation was completed and put in operation, the first cold weather was just beginning, and the snow and ice in a short time made the road from Domene to Revel impassable for any description of vehicles. From the end of November to the middle of March this continued, so that for over four months hardly the smallest load could be carried up to La Force. In spite of this, however, the working was never stopped, nor did the snow or the ice effect the line of transmission. The same result followed during the spring storms, when also there was no interruption whatever to the work. It is only necessary to supply the men in charge of the dynamos with provisions, with oil for lubrication, etc. The station is united with the mill by a telephone line carried on the same posts as the line of transmission, and communication is consequently maintained.

Four persons are especially employed on the electric work, two having charge of the generating dynamo at La Force and two of the receiver at the mill. One is constantly on duty at each end, the men taking their turns at day and night service. The conductor at the receiver is under the direct orders of the man who is running the dynamo, and performs the same functions as an engineer in an ordinary mill. In this case the two employés who hold the position at the receiver are the two old engineers of the mill.

THE NEW FAST CRUISER.

THE accompanying illustration, which is prepared from a photograph furnished by the Navy Department, shows the design adopted for the new swift cruiser of 7,300 tons displacement—the largest cruiser yet designed for the Navy—officially designated as Cruiser No. 12.

The building of this vessel was authorized by the Navy appropriation bill of 1890, and proposals for building it have been invited. The description given below embodies substantially the specifications issued by the Navy Department.

Bids will be received for constructing ship and engines in accordance with the plans prepared by the Department, or on plans to be furnished by bidders. In the latter case, however, the plans submitted must conform to certain requirements, which are substantially as follows: All parts and material must be of domestic manufacture, and in compliance with the provisions of the act of August 3, 1886. The contractor must guarantee an average speed in the open sea, under conditions prescribed by the Navy Department, of 21 knots per hour, maintained for 4 consecutive hours, during which period the air pressure in the fire-rooms shall not exceed 1 in. of water, and for every quarter-knot of speed so developed above said guarantee, the contractor shall receive a premium over and above the contract price of $50,000, and for every quarter-knot that the vessel fails of reaching the required speed, there shall be deducted from the contract price the sum of $25,000.

The vessel must be completed within 2½ years after the contract is signed.

The Department plans call for a vessel 400 ft. long on the mean load line; beam, moulded, 58 ft.; draft, mean normal, 23 ft.; extreme normal, 24 ft. Displacement, normal, about 7,300 tons; speed, sustained, 21 knots; and indicated H.P., 20,500.

The main battery consists of four 6-in. breech-loading rifles, of high power; eight 4-in. breech-loading rifles, rapid firing; about 18 machine guns, and 6 torpedo tubes.

The arrangement of the motive power will be somewhat novel, as the force will be transmitted through three screws: one placed amidships, as in ordinary single-screw vessels, and two others placed further forward, one on each side, as is usual in twin-screw vessels; this arrangement is not entirely new, having been adopted by the French for some of their later vessels, but represents the latest advance in the steam engineering line where such great power is to be transmitted. If twin screws were used, over 10,000 H.P. would pass through one shaft; now each shaft transmits only 6,850 H.P., and the vessel has one more chance in case of break-down.

The machinery and boilers were designed by Engineer-in-Chief George W. Melville, U. S. N., Chief of Bureau of Steam Engineering, and consists of three sets of triple-expansion, vertical, inverted cylinder engines, driving the triple screws before mentioned. The center screw is about 4 ft. 6 in. below the other two.

Fig. 2 is a plan showing the arrangement of the three screws. Fig. 3 is a rear view, on a somewhat larger scale, showing also the position of the screws. The side screws are three-bladed and are each 13 ft. 9 in. in diameter; the middle screw is four-bladed, and is 12 ft. in diameter. The middle screw is 4 ft. 6 in. lower than the side screws, and 15 ft. farther aft. It will have a somewhat coarser pitch than the side screws. The centers of the side screws will be immersed about 12 ft. at ordinary load draft.

Each engine is placed in a water-tight compartment, and is complete in every respect, so that the vessel may be propelled at a slow speed by the center screw alone; by the two outer screws at a medium speed; and by the three screws when the highest rate of speed is required. Each shaft is fitted with a disengaging coupling, so that when not in use the propellers are free to revolve.

The great advantage of this arrangement is that it allows the machinery to be worked at its maximum and most economical number of revolutions at all rates of the vessel's speed; and each engine can always be used for propelling the vessel, an advantage of great importance, and one that the arrangement of two sets of engines working on the same screw does not possess.

The steam pressure is 160 lbs. The diameter of high-pressure cylinder is 42 in.; of intermediate pressure cylinder, 59 in.; of low-pressure cylinder, 92 in.; stroke, 42 in.

The shafting is made of forged steel 16.5 in. in diameter, with an axial hole 7.5 in. in diameter. Steel has been used wherever possible, so as to make the machinery as light as is consistent with safety.

The total capacity of the circulating pumps per minute when used for bilge purposes is 40,500 gallons.

The total indicated power at 129 revolutions per minute and a forced draft of 1 in. of water is 21,000 H.P.

There are eight main double-ended boilers, placed in four water-tight compartments, and two single-ended, auxiliary boilers placed on the berth deck. The air-tight fire-room system of forced draft is used.

Six of the double-ended boilers are 15 ft. 6 in. in diameter and 21 ft. 6 in. long, each having 8 furnaces and 175.5 sq. ft. of grate surface, and 5,952.4 sq. ft. of heating surface.

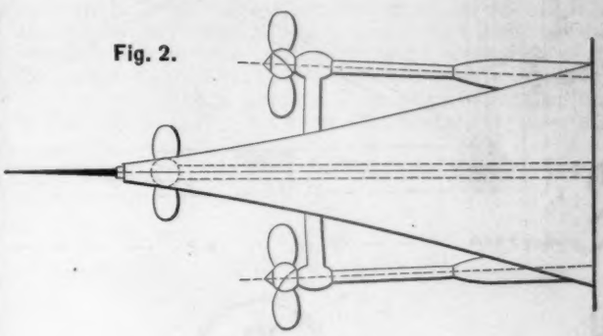
Two of the double-ended boilers are 11 ft. 8 in. in diameter and 18 ft. 8.5 in. long, each having four furnaces and 84 sq. ft. of grate surface and 2,870 sq. ft. of heating surface. The total grate surface for the main boilers is 1,221 sq. ft.; the total heating surface for the main boilers is 41,334.4 sq. ft.

Each auxiliary boiler is 10 ft. in diameter and 8 ft. 6 in. long, with two furnaces, and has 32 sq. ft. of grate surface and 968.5 sq. ft. of heating surface. The total grate surface for auxiliary boilers is 64 sq. ft.; the total heating surface is 1,937 sq. ft.

All the boilers are constructed of steel for a working pressure of 160 lbs.

The vital portions of the vessel are protected by an armored deck 4 in. thick on slopes and 2½ in. on the flat; the space between this deck and the gun-deck will be minutely subdivided by coal bunkers and store-rooms; in addition to these a coffer-dam 5 ft. in width will be worked next to the ship's side for the whole length of the vessel. In the bunkers this will be filled with patent fuel, forming a wall 5 ft. thick against machine-gun fire; the contents can also be utilized as fuel in an emergency. Forward and aft the coal bunkers, the coffer-dam will be filled with some water-excluding substance similar to woodite.

Fig. 2.



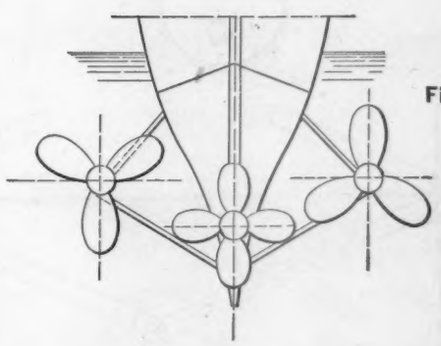


Fig. 3.

In wake of the 4-in. and the machine guns the ship's side will be armored with 4-in. and 2-in. plates.

The 6-in. guns are mounted in the open, protected by heavy shields attached to the gun carriages.

The accommodations for officers and crew are spacious, well ventilated and lighted. All the most approved modern appliances for exhausting vitiated air and for incandescent lighting by electricity have been incorporated in the design.

The coal capacity is very large, reaching 2,000 tons; at 10 knots' speed per hour this will give the vessel an endurance of 109 days, or a radius of action of 26,240 knots; in other words, she will be able to steam around the world in 109 days without recoaling.

In appearance the vessel resembles closely an ordinary merchantman, the sides being nearly clear of projections or sponsons, which ordinarily appear on vessels of war; she will have two signal masts, which will have no military tops on them, however.

The function of the vessel is to destroy the commerce of an enemy; therefore, her general appearance is such as to enable her to get within range before her character is discovered.

As a whole, this vessel will represent the latest idea of a powerful, economical, protected commerce destroyer.

The hull will be of steel; the vitals of the ship and its stability well protected, and the gun-stations shielded against machine-guns.

The subdivision of the hull is such as to form a double hull below the water, and offers as great security against damage from torpedo attack as can be given in a vessel of this class.

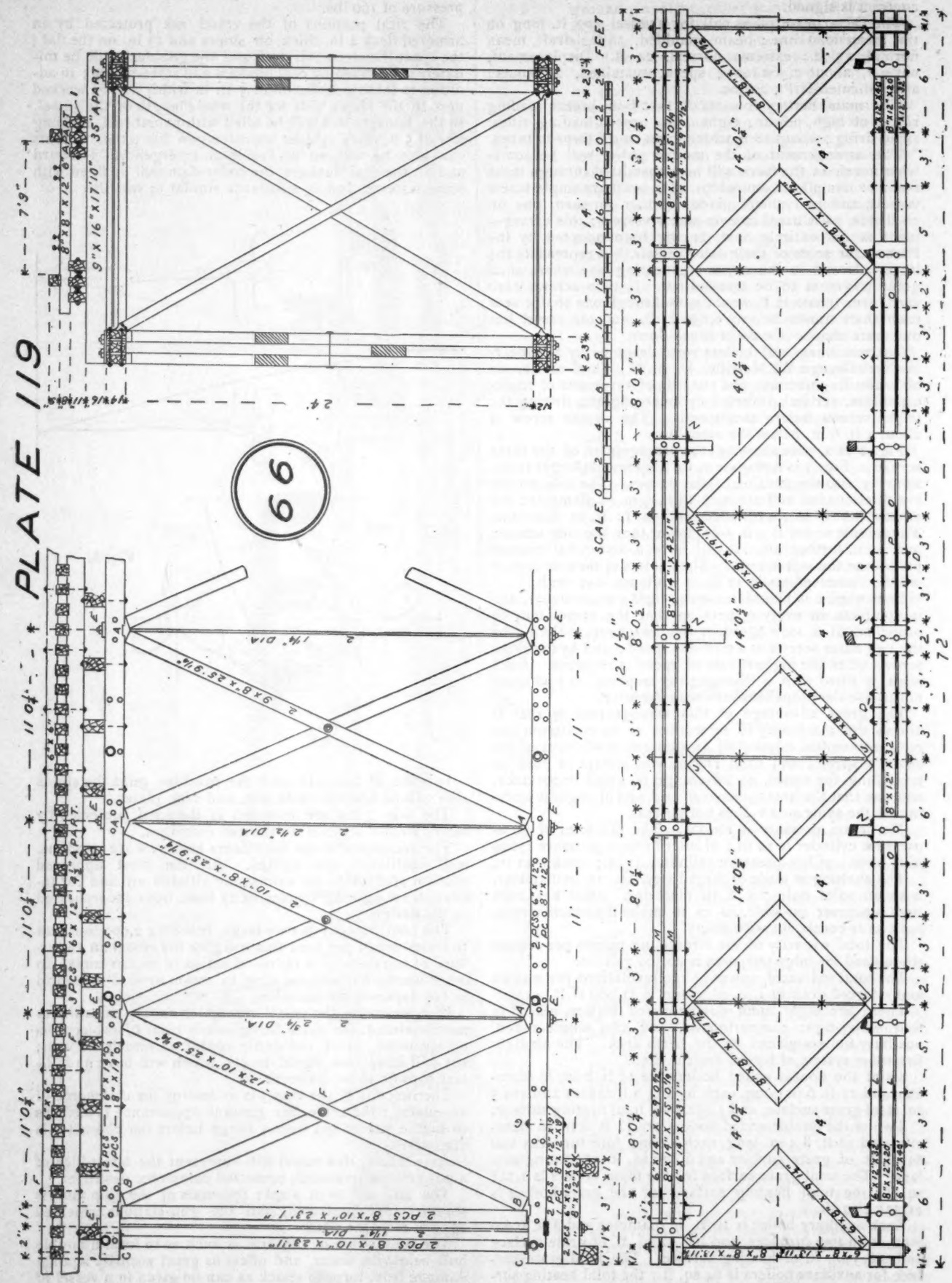


PLATE 119
66
SCALE 0 2 4 8 10 12 14 16 18 20 22 24 FEET

THE USE OF WOOD IN RAILROAD STRUCTURES.

By Charles Davis Jameson, C.E.

(Copyright, 1889, by M. N. Forney.)

(*Continued from page 400.*)

CHAPTER XXVIII.

HOWE TRUSS BRIDGES.

Plates 119, 120 and 121 show a design for a Howe truss deck bridge of 66 ft. span. Plate 119 shows the general design, while the details will be found in plates 120 and 121.

The bill of materials given herewith will, with the plates, give all that is necessary to understand fully the construction of the bridge.

No. 48. Bill of Material for Howe Truss Bridge. Deck Span, 66 Ft. Plates 119, 120 and 121.

Timber.

No. of Pieces.	Description.	Size.	Length.	Ft. Board M's're.	Kind of Wood.
4	Top Chord.....	6 in. × 14 in.	43 ft. 1 in.	1,207	Yellow Pine.
4	" "	6 in. × 14 in.	29 ft. 1½ in.	816	" "
4	" "	8 in. × 14 in.	15 ft. 0¾ in.	564	" "
2	" "	8 in. × 14 in.	42 ft. 1 in.	786	" "
4	Bottom Chord..	6 in. × 12 in.	40 ft. 0 in.	960	" "
4	" " ..	6 in. × 12 in.	32 ft. 0 in.	768	" "
4	" " ..	8 in. × 12 in.	20 ft. 0 in.	640	" "
2	" " ..	8 in. × 12 in.	32 ft. 0 in.	512	" "
8	Braces	12 in. × 8 in.	25 ft. 9¼ in.	2,064	" "
8	"	10 in. × 8 in	25 ft. 9¼ in.	1,384	" "
8	"	9 in. × 8 in.	25 ft. 9¼ in.	1,240	" "
12	Counters.....	9 in. × 7 in.	25 ft. 9¼ in.	1,320	" "
16	End Posts... ..	8 in. × 10 in.	23 ft. 11 in.	2,560	" "
10	Laterals.....	6 in. × 8 in.	19 ft. 1½ in.	770	" "
10	"	8 in. × 8 in.	19 ft. 1½ in.	1,020	" "
2	"	6 in. × 8 in.	13 ft. 11¼ in.	112	" "
2	"	8 in. × 8 in.	13 ft. 11¼ in.	150	" "
8	Bolsters.....	6 in. × 12 in.	9 ft. 0 in.	432	" "
4	"	8 in. × 12 in.	9 ft. 0 in.	288	" "
8	Bridge-seats....	6 in. × 12 in.	6 ft. 0 in.	288	" "
4	" "	8 in. × 12 in.	6 ft. 0 in.	192	" "
4	Sills.....	12 in. × 12 in.	18 ft. 0 in.	864	Spruce or Pine.
20	Floor-beams	9 in. × 16 in.	18 ft. 0 in.	4,320	" " "
6	Stringers.....	6 in. × 12 in.	72 ft. 0 in.	2,592	" " "
62	Ties.....	8 in. × 8 in.	12 ft. 0 in.	.....	Oak.
2	Guards.....	6 in. × 6 in.	72 ft. 0 in.	532	Spruce or Pine.
4	Plank.....	2 in. × 8 in.	72 ft. 0 in.	384	" " "
8	Blocks.....	2 in. × 8 in.	2 ft. 0 in.	24	Oak.

Wrought-Iron—Rods and Bolts.

No.	Description.	Diameter.	Length.	No.	Description.	Diameter.	Length.
8	Rods... ...	2¾ in.	26 ft. 10 in.	12	Bolster b'lts	1¼ in.	2 ft. 4 in.
8	"	2½ in.	26 ft. 10 in.	12	" "	1¼ in.	3 ft. 4 in.
8	"	2½ in.	28 ft. 10 in.	20	Fl.beam b'ts	1¼ in.	4 ft. 4 in.
4	"	1¾ in.	26 ft. 10 in.	48	String'rb'lts	¾ in.	2 ft. 6 in.
8	Laterals....	1½ in.	18 ft. 6 in.	28	Tie-bolts.	¾ in.	2 ft. 6 in.
4	" ...	1¼ in.	18 ft. 6 in.	28	G'rd-r'l-b'lts	¾ in.	1 ft. 3 in.
192	Chord-bolts.	¾ in.	2 ft. 0½ in.	24	Spikes.....	⅝ in.	9 in.
12	Brace-bolts.	¾ in.	2 ft. 0½ in.				

Other Iron Work.

Washers: 650 of pattern *F*; 88 of *G*; 24 of *H*.

Castings: 20 of pattern *A*; 8 of *B*; 4 of *C*; 4 of *D*; 28 of *E*; 36 of *I*; 16 of *J*; 8 of *K*; 72 of *L*; 64 of *M*; 28 of *N*; 24 of *O*; 6 of *P*; 12 of *Q*.

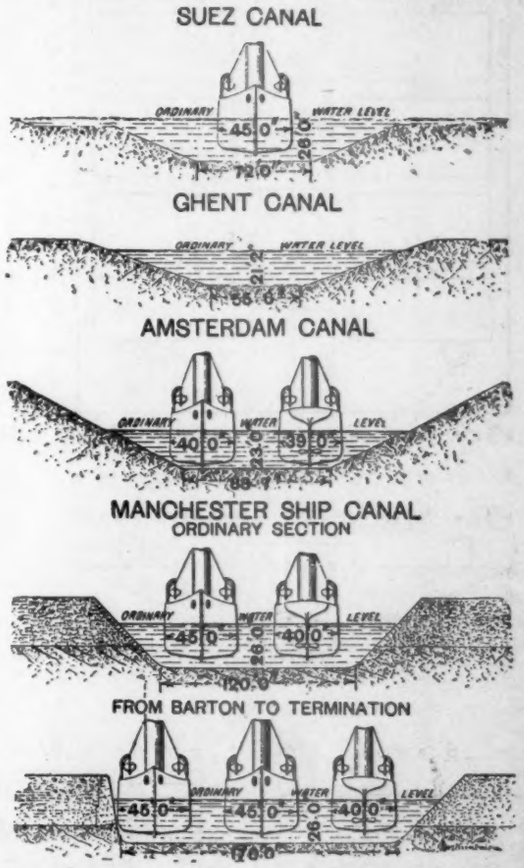
The kind of timber used may be changed when necessary, though that given is the best.

(To be continued.)

THE MANCHESTER SHIP CANAL.

Work on the Manchester Ship Canal, perhaps the greatest engineering work under construction in England, is now in progress on a large scale. It is intended to give access for large vessels to the great manufacturing city of Manchester, and the projectors believe that the saving effected by the delivery of raw materials and the loading of manufactured goods at the wharf in Manchester, avoiding the cost of trans-shipment and the railroad haul from Liverpool, will be a great benefit to the city.

The canal begins not far from Liverpool, at the village of Eastham, on the Cheshire side of the Mersey, and ends at Throstle Nest, Manchester, in a group of docks; it is about 35½ miles long, and has a minimum width at the bottom of 120 ft., with a minimum depth throughout of 26 ft.; compared with the Suez Canal, the depth is the same, but the width is 48 ft. greater. The cross sections of the various canals given in the accompanying cut show the



capabilities of the Manchester Ship Canal in comparison with those of others. The railroads over the canal will be carried by high-level bridges, and the roadways by swing bridges, the minimum clear height under the fixed railroad bridges being 75 ft. The water supply of the canal is to be derived from the Irwell, Mersey, Bollin, and other smaller streams; but, if necessary, pumping will be resorted to to make up the loss through lockage.

The line follows the south bank of the River Mersey for a considerable distance very closely. After leaving the river bank it still follows the valley of the Mersey to Irlam, whence it runs up that of a tributary, the Irwell, to Manchester.

There are five sets of locks, the first, at Eastham, being a tidal lock through which vessels pass from the river to the canal. The second lock is at Latchford, 20½ miles from Eastham, and has 16 ft. 6 in. lift; the third is at Irlam, 28 miles from Eastham and has 16 ft. lift; the fourth is at Barton 30½ miles from Eastham, and has 15 ft. lift; the fifth is at Mode Wheel, 33½ miles from Eastham, and has 13 ft. lift.

PLATE 120

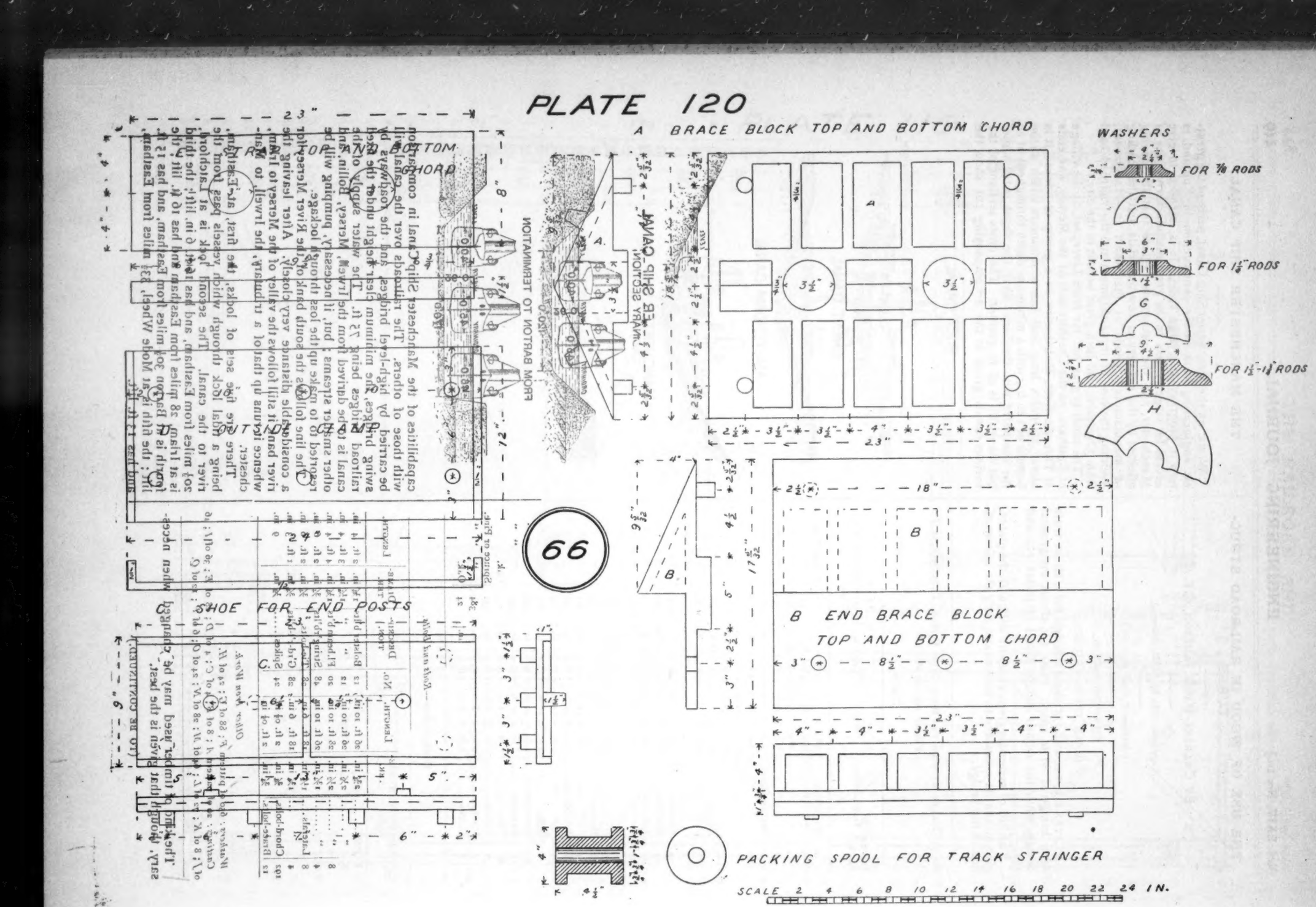
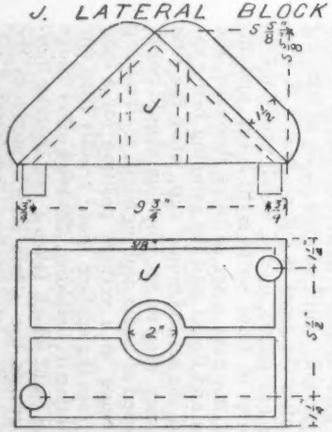
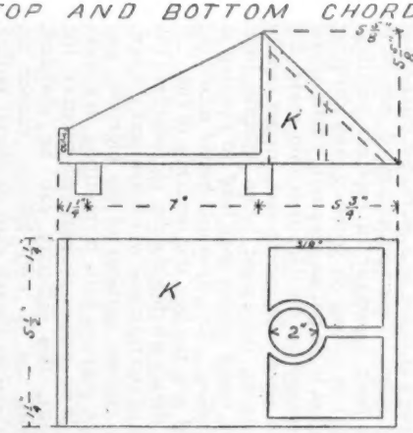

A BRACE BLOCK TOP AND BOTTOM CHORD
WASHERS
FOR ⅞ RODS
FOR 1¼" RODS
FOR 1½-1⅝ RODS
B END BRACE BLOCK
TOP AND BOTTOM CHORD
SHOE FOR END POSTS
PACKING SPOOL FOR TRACK STRINGER
SCALE 2 4 6 8 10 12 14 16 18 20 22 24 IN.

PLATE 121

J. LATERAL BLOCK TOP AND BOTTOM CHORD

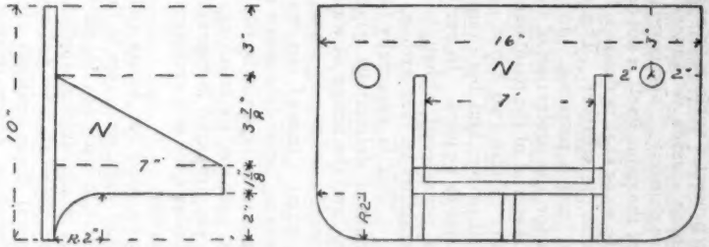


K. END LATERAL BLOCK



66

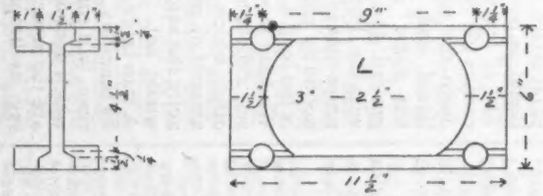
N. SHOE FOR INTERNAL BRACES



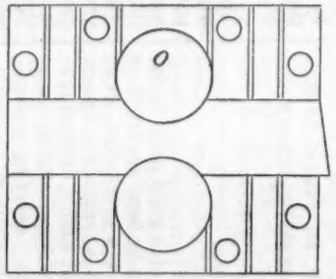
Q

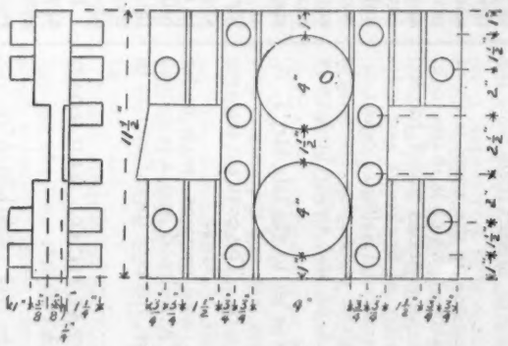
Q CLAMP KEY

L. PACKING BLOCK BOTTOM CHORD

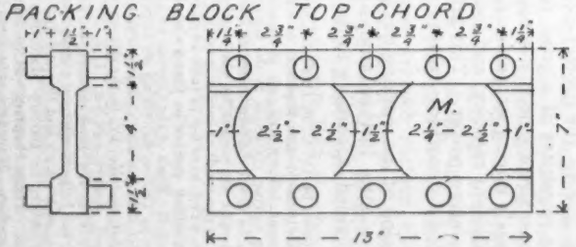


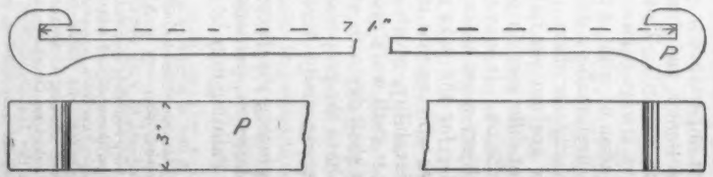
O. CLAMP HEAD



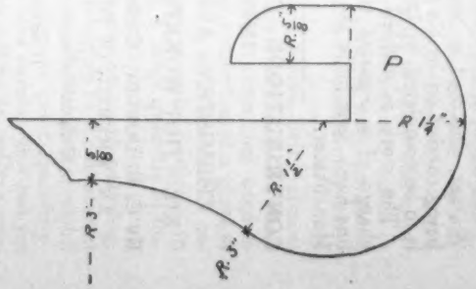


M. PACKING BLOCK TOP CHORD





P. CLAMP BAR



P. CLAMP BAR HEAD

SCALE 2 4 6 8 10 12 14 16 18 20 22 24 IN.

The total lift is thus 60 ft. 6 in. The canal is divided into five levels, the length of which, respectively, is 20½, 7½, 2½, 3 and 2 miles.

The width of the canal at the top varies, of course, with the slopes of the sides; these are made ranging from 1 in 6 through rock to 2 to 1 in clay and soft material. Except when passing through rock, the slopes are pitched with rough stone on a rubble backing to protect them from the wash of passing vessels.

The total amount of excavations in the canal is about 47¼ million cubic yards, one-sixth of which is in the rock. The walling of the various locks contains about 700,000 cubic yards of concrete, exclusive of brickwork and masonry; the walls of the Manchester and Salford Docks contain about 600,000 cubic yards of concrete. The weight of steel and ironwork in the fixed and swing bridges is about 15,000 tons.

The whole of the contract was let to the late Mr. T. A. Walker, who died in November last, and the work is now being carried on by his executors. The contract requires it to be completed by December 31, 1891.

The work is divided into nine sections, each under charge of a separate staff. A railroad and a telephone line have been built the whole distance from Eastham to Manchester.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.*

CHEMISTRY APPLIED TO RAILROADS.

XII.—THE WORKING QUALITIES OF PAINT.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(Copyright, 1889, by C. B. Dudley and F. N. Pease.)

(*Continued from page 417.*)

In our analyses of the requisites of a good paint in the last article, one point which has usually been regarded as of very great importance in paints, was overlooked, or at least not mentioned, and this is what is technically known as "covering power." This was not wholly unintentional, as we have always been somewhat skeptical of the common explanation of what is known as "covering power." There is unquestionably a difference in different pigments, as we ordinarily use them, in their ability to hide a surface, but we are not yet fully satisfied as to whether this is an inherent difference in pigments, or is a difference of physical condition. It may possibly be both, but we will treat this subject more at length later.

Meanwhile, for the sake of having the subject clearly before us, we will say that the requisites of a good paint are, first, durability, which has already been discussed; second, that it shall work properly during its application; third, that it shall dry with sufficient rapidity, and fourth, that it shall have the proper covering power. This article will be more especially devoted to working qualities of paint.

Before beginning the discussion of the working qualities of a paint, however, perhaps a little further analysis is necessary. Painting may be divided, according to the use to which the paint is put, and especially according to whether it is expected to protect a surface or not, into two classes. The first of these classes is generally known under the head of "house painting," and covers the painting of all surfaces, where the paint itself is not only expected to give the appropriate color that is desired, but also to protect the surface against the weather. The other kind of painting is known as "coach painting," in which the color is the thing sought for, the protection of the surface, and also of the coloring material of the paint being secured principally by the varnish. These two kinds of painting are characteristic and distinctive, and both require different qualities in the material to be used. In our last article only house painting was considered, although much that was said in regard to durability in that article, will apply equally well to varnish This is especially true of mechanical injury, the action of deleterious gases, the destruction during cleaning, and the action of water, which, as will be remembered, were cited among others as causes for the deterioration of paint. Indeed, we really do not know of any additional cause, beyond the seven mentioned in the last article, which interferes with the life and durability of varnish, except, perhaps, its cracking, and upon this point we are hardly yet prepared to express any positive opinions. In what follows we will endeavor to recognize the two kinds of painting.

In order that paint, to be used for house painting and analogous purposes, should work well, two or three points seem to be essential. First, it must not run off the work; second, the brush marks made during application must disappear later; and third, the work must not appear spotted or streaked. In general these qualities are obtained by what is commonly known as proper mixing, although the grinding, the purity of the oil, and the kind of dryer used all have influences.

The running of paint may be due to two or three causes. The paint may be applied too thickly for the kind of paint used; for example, to put on as thick a coat of very thin paint as paint containing a larger percentage of pigment, would inevitably result in the paint running. Of course linseed oil alone can be applied to a surface with a brush without running, provided too much is not put on, and the greater the percentage of liquid in a paint, the thinner the coat must necessarily be. This application of thin coats is a very common fault, especially in contract painting. Where the pigment is strong in coloring and covering power, the temptation is to put on very thin coats, which temptation is increased by the fact that thin coats dry quicker than thick ones. Of course with proper care in using a very thin paint, there need be no difficulty from running. Another cause which may lead to running is want of proper grinding. The finer and better mixed the pigment and liquid are, the less the tendency to run. A paint mixed up by simply stirring the dry pigment into the liquid, is more apt to run than one which has been ground. The oil leaves the coarser portions of the pigment, and carries off the finer portions with it, resulting in streaks down the work. With proper proportions between the liquid and pigment, this difficulty can be obviated, but some pigments, as is well known, cannot be ground, and are therefore always used by simply mixing with the liquid, but a paint otherwise good and properly proportioned may give difficulty from running, if it was not finely enough ground. Still another cause of running is too long a time after the paint is put on before it sets. We have mixed up two paints, one of which would take a set, although not dry, in from six to eight hours, and another which would not take a set in twice that time, the amount of pigment and liquid and the grinding being exactly the same, and the second would run, while the first would not. It is very easy to see why this should be so. A thin layer composed of liquid and pigment, maintaining its limpidity, and being in a vertical position for a long time, will run off from the surface more readily than one which does not maintain its limpidity, although other things are the same. The paint which takes a set, thereby loosing its limpidity, resists the strain which produces the flowing or running in the other paint. Adulterated oil, especially linseed oil, containing petroleum product, is liable to this same difficulty, and for the same reason,

* The above is one of a series of articles by Dr. C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad, who are in charge of the testing laboratory at Altoona. They will give summaries of original researches and of work done in testing materials in the laboratory referred to, and very complete specifications of the different kinds of material which are used on the road and which must be bought by the Company. These specifications have been prepared as the result of careful investigations, and will be given in full, with the reasons which have led to their adoption.

The articles will contain information which cannot be found elsewhere. No. I, in the JOURNAL for December, is on the Work of the Chemist on a Railroad; No. II, in the January number, is on Tallow, describing its impurities and adulterations, and their injurious effects on the machinery to which it is applied; No. III, in the February number, and No. IV, in the March number, are on Lard Oil; No. V, in the April number, and No. VI, in the May number, on Petroleum Products; No. VII, in the June number, on Lubricants and Burning Oils; No. VIII, in the July number, on the Method of Purchasing Oils; No. IX, also in the July number, on Hot Box and Lubricating Greases; No. X, in the August number, on Battery Materials; No. XI, in the September number, on Paints. These chapters will be followed by others on different kinds of railroad supplies. Managers, superintendents, purchasing agents and others will find these CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION of special value in indicating the true character of the materials they must use and buy.

namely, the oil on the surface maintains its limpidity for a long time, thus giving gravity a long time in which to act upon the paint. The obvious remedy for running due to this cause is to use such an amount of dryer, with pure oil, that it will take a set in from four to eight hours, and where the difficulty is due to adulterated oil, the remedy is apparent without explanation.

The difficulty of the brush marks remaining prominent in paint is largely a question of the relative amounts of liquid and pigment, although not wholly so. The nature of the liquid used comes in as an element. For example, if a large amount of very thick japan is a constituent of the paint, or a heavy, viscous, boiled oil, other things being equal, the brush marks will have a tendency to be more prominent than where raw linseed oil and a limpid japan are used, but the proportions of liquid and pigment are, nevertheless, in all cases the important consideration. If the liquid is viscous and sluggish in movement, less pigment is required; with a very limpid liquid more pigment can be used, without causing the brush marks to be prominent. It is also quite probable that the grinding has an influence on the degree of permanence of the brush marks. Coarsely ground paint, under no circumstances, would allow the brush marks to flow out as readily as where the pigment is in a very fine state of division, and with that perfect union between the pigment and the liquid which is produced by fine grinding.

Streaked or spotted painting may be due to two or three causes. It often happens that the pigments made use of are what may fairly be termed "composite," by which is meant different chemical substances constitute pigments, and often in cases where the pigment is nearly all one chemical substance, as in chrome yellow or white lead, it frequently follows that materials made at different times differ in both shade and fineness, but are subsequently mixed together. In all cases where a pigment is composite our experiments seem to indicate that there is a tendency for the very finest particles to separate from those which are coarser, so that each successive brushful taken out of the bucket may contain a larger percentage of the fine, and a smaller percentage of the coarse particles than the previous brushful, at least while the first half of the bucket full is being used out. In some paints it is actually noticeable that the last end of the job is of a different shade from the first, especially if the painter has not stirred his bucket of paint frequently. This separation of the different constituents of the paint is also especially true of those composite pigments which are made up of some heavy bases, with some organic or light coloring matter; for example, Tuscan red, which, as is well known, is a mixture of oxide of iron known as Indian red, with some of the red lakes. It may fairly be claimed that this difficulty of spotted or streaked work is more a question of care on the part of the painter than of the proper mixing or proportioning of the paint, and this is to a certain extent true, but it is not wholly so. Poorly ground paint is especially liable to give streaked results, and no amount of subsequent stirring or mixing on the part of the painter will make a pigment consisting of very coarse and very fine particles a good one to spread, or make it give a good-looking job. Both fine grinding and great care on the part of the painter are essential to obviate this difficulty. It of course goes without saying that those pigments which, from their nature, have a tendency to produce this difficulty, should not be mixed where it can be avoided, although in our belief fine grinding will almost entirely overcome it with any pigments, whatever they may be.

It will be observed from above discussion that the essentials of good working house paints are fine grinding, pure oil, proper mixing, and the proper amount of dryer, together with good judgment and care on the part of the painter. Of these essentials the grinding and the use of pure materials are incumbent on the parties furnishing the paint. The proper proportioning of the pigment and liquid, the use of dryer of the right kind and in the right amount, and the skill and care during the application, are incumbent on the foreman painter or his subordinates. It may be thought that in treating this subject of the proper application of the paint, the brush may be regarded as an essential element, and this undoubtedly does have an influence, especially in brush marks. However, our experience indicates that this element is less important than would generally be thought, as a skillful painter, even with a poor brush, will make a good job, where an unskillful man with a good brush fails. We think it fair to say, however, that it is more wearisome to the arm, and more difficult to get good results with stiff brushes than with those which are more soft and pliable; also in our judgment there is very little economy in using poor brushes.

The proportioning of pigment and liquid to give good spreading paints, as well as how to proportion pigment and liquid in paint for grinding, both will be taken up a little later. We have made some very positive experiments on these points, and hope to be able to give a rule which will approximately, at least, enable successive batches of paint to be mixed so that they will work alike, and also possibly enable new pigments to be mixed for grinding without the necessity for going through with preliminary experiments. If we succeed as well as our experiments promise, the rule which we give will eliminate the uncertainty due to the addition of indefinite amounts of liquid to paste, and eliminate also the individual judgment of the painter, which is now, unfortunately, not rare, and to which, perhaps, some of the difficulties now experienced with paints may fairly be attributed.

Coach painting, as has been stated above, being almost entirely a question of color, requires that the paint when applied, shall be considerably different from that used in house painting. In the latter case somewhat of a gloss is desirable, and quite a large quantity of linseed oil is essential with our present knowledge of paint liquids. In coach painting, on the other hand, a large quantity of linseed oil is fatal, and no gloss is desired in the dried paint. It is not our intention to give a treatise on coach painting, beginning with the wood, and coming up to the final coat of varnish, as at present the question of surfaces, which make the ground work for the color in coach painting, has not been sufficiently studied; also varnish has not yet been sufficiently studied to make us willing to publish anything in regard to it. The color used in coach painting, however, we have studied somewhat, and this is the material the application of which we are discussing. In addition to the points mentioned above, which are requisite in order to secure good house painting paints, namely, fine grinding, pure materials, proper mixing, proper kind and amount of dryers, and care and good judgment on the part of the painter, there are some difficulties which are characteristic of coach painting which do not occur, to any great extent, at least, in house painting. These difficulties are such that, as we understand the matter, the additional requisites of a good coach color are, it must not dry too quickly, it must not roll up under the brush, it must dry "flat," and it must cover the surface.

Where coach color dries too fast, it is impossible to brush it out smooth, and also to join on to the work last finished, with the next application. As is well known, coach color is almost always applied to a prepared surface, formed by laying on the wood or iron a foundation of surfaces of some kind, and rubbing these down to get a flat and smooth surface almost impervious to the color. In order to get the paint evenly spread, therefore, over this prepared surface, a proper amount of brushing is necessary, since, as is well known, each full brush leaves more paint where it first touches than on the surface coated with the remainder of the stroke. If, now, the paint dries too fast, it is impossible to give it sufficient brushing to get the surface evenly covered. Furthermore, as is clearly evident, the whole side of a car body or other portion of the same cannot be coated at once. Successive portions within reach of the painter are coated, and then by change of position, the contiguous portions. In joining, the paint being applied to that previously applied, it is not infrequent that serious difficulty occurs, and this is always true if the paint dries too fast. In this case the paint, which has already been on for some time and is partially dry, rolls up under the brush and gives a bad looking job. Too large a percentage of dryer, or not enough turpentine, are the probable causes of too rapid drying. Of course the constitution of the paint has an influence; for example, with a paint ground in japan alone, the proportion of the di-

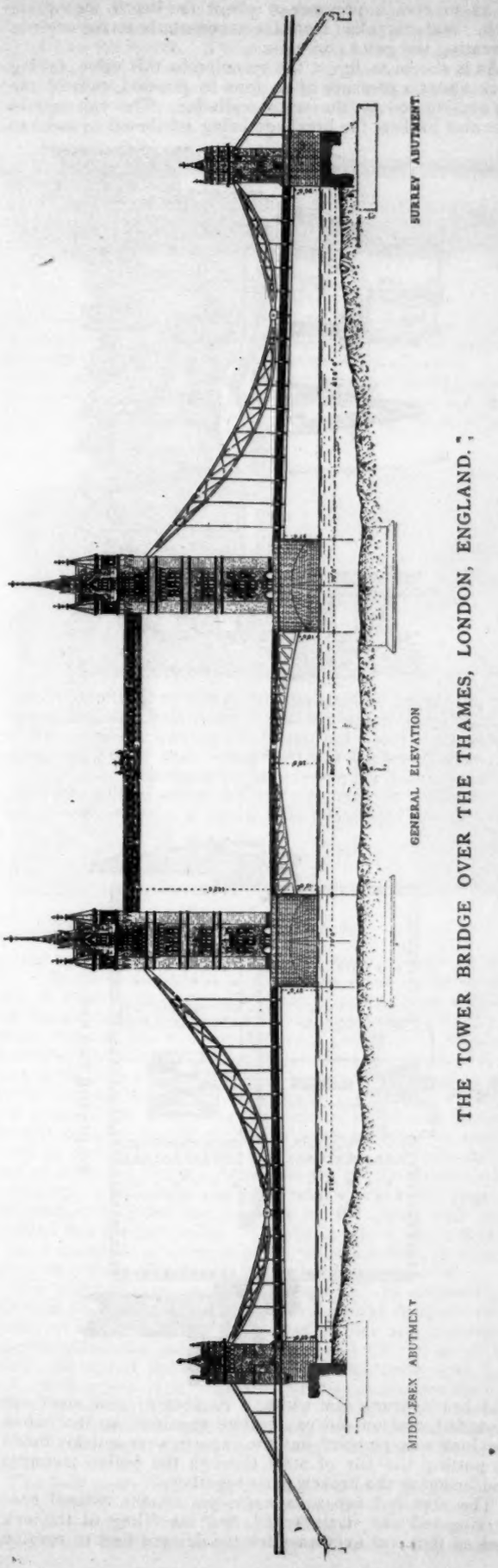
luting material added, either turpentine or oil or more japan, would have to be different than with a paint ground in oil and turpentine, but we think it will be found in general that the proportion of turpentine on one side, and the japan and oil on the other, are the variables which control the drying.

The rolling of coach color under the brush is due to two causes—either too rapid drying, or to being mixed too thick. If a brushful of paint cannot be applied to a surface, and the surface be gone over several times with the brush, so as to secure an even covering, as is above described, without the paint rolling up under the brush, it is evidence that the paint dries too rapidly as already explained, or that it contains too much pigment for the liquid. In practice we believe it is generally due to both causes that coach color rolls up under the brush, and the most common remedy is simply to add turpentine which both retards the drying and at the same time dilutes the paint so as to give a more limpid material.

Flat color, as is well known by those accustomed to painting, is simply a coat of paint without any gloss. In coach painting it is believed to be absolutely essential that the color should dry "flat," since if the color has gloss of any kind, the subsequent application of the varnish is not successful, since the varnish crawls off from a glossy surface, leaving spots, the tendency being for the varnish to assume the form of globules on the surface, rather than to lie in a thin layer over it. With color which is sufficiently flat, and with a good varnish, this result does not take place. There has been some study made as to what produces flat color, some claiming that it can only be produced by japan and turpentine, and that no linseed oil must be present; if so the color cannot be made flat, since linseed oil usually dries with a gloss. We have made a number of experiments on this point, and are inclined to think that flat color can be produced with any liquid, even with varnish, which, as is well known, always dries under proper conditions with a gloss, and is used for that purpose. Our experiments indicate that the explanation of flat color is as follows: For purposes of application paint must be made thin enough so that it will spread with a brush. A paste sufficiently thick for this purpose, at least, cannot be spread with a brush. This thinning of paint for spreading purposes is usually done with oil, japan and turpentine. When the paint comes to dry, the turpentine, or at least by far the larger part of it, evaporates. The non-volatile part of the japan and the oil are left behind, and hold the pigment on to the surface after the chemical change called drying has taken place. If, now, the ratio of pigment to binding material, comprehending under the words binding material the substances which hold the pigment to the surface, namely, the non-volatile part of the japan and the oil, is, say, 50 parts pigment to 40 parts binding material by weight, the paint will have more or less gloss, depending some on the nature of the binding material. This ratio of 50 to 40 by weight, however, only holds for pigments which have about the specific gravity of Venetian red, Tuscan red, Indian red, etc. If, on the other hand, the ratio of pigment to binding material is about 75 parts pigment to 10 or 12 parts of binding material, the paint will be flat, and our experiments indicate that this is the case whatever may be the binding material. The same restriction as to specific gravity of pigment holds in this case likewise. We have actually obtained perfectly flat color by taking a paste ground in oil and turpentine, where the oil was only about 8 per cent. of the weight of the paste, and diluted it with turpentine, so that it could be spread, and obtained perfectly flat color without any japan whatever. We are confident flat color is simply a question of proper ratio between pigment and binding material. It is fair to say that many of the pigments cannot be ground in a small enough amount of oil, so that by dilution and spreading flat color can be obtained. For example, Tuscan red requires 75 parts pigment and 25 parts oil in order to grind fairly well. With this ratio of pigment and oil, the oil subsequently becoming the binding material, flat color cannot be obtained. This difficulty has led the manufacturers to grind many colors in japan, or oil and turpentine, the more common practice being, we believe, to grind in japan alone, and it is possible this practice has led many to think that japan was essential in obtaining flat color. Upon the question of grinding for flat color, we prefer oil and turpentine rather than japan, for reasons which will be given when we come to discuss our specifications for Tuscan red; but irrespective of the material used in grinding, we are confident that any color can be made flat if the amount of binding material, when the paint is dry, bears a sufficiently small ratio to the pigment. If this statement is correct, it will be seen that the mixing of paint for flat color is not a very simple matter. If the color is ground in japan alone it is possible that simply diluting with turpentine may give what is required. If the pigment is ground in oil and turpentine some japan must, of course, be added, and then turpentine to dilute with. There is need of definite figures as to the ratio of pigment to binding material for all colors. We have not yet had time to go over the ground, but possibly may succeed a little later in giving a rule which will apply to various colors.

The difficulty just mentioned, of not having so much binding material that the paint will not dry flat, causes coach color, when mixed for spreading, to be very thin, since it contains so large a percentage of turpentine, and unless care is taken, the color will be so thin that it will not cover the surface. Indeed, as is well known among practical painters, coach color mixed to dry flat requires at least three coats to get the proper amount of color on the surface, whereas as required for house painting two coats will give a layer as thick or thicker even than three coats of coach color. If too much turpentine is used, making the paint, as said above, too thin, the only real serious difficulty is that a good many coats must be put on in order to get the requisite body of color, and it is also of course obvious that, other things being as they should be, the remedy for this state of affairs is not to use too much turpentine in diluting coach color. This, however, is not all of the problem, as will appear from what follows. In our view of the case there is a radical distinction, which will be brought forward a number of times as our discussion of the paint problem continues, between the pigment used in house painting and the pigment used for coach color, and we hope to make clear later, in discussing house painting, that the pigment may be largely some inert material, only enough coloring matter being required, in our judgment, to give the proper shade. Of course if this amount of coloring matter is not enough to make the material cover well, it will be necessary to add to the inert material some good covering pigment. These points will be worked out in detail in a subsequent article. It is sufficient for our purpose here to say that, in paints to be used for house painting, such for example, as all the oxide of iron paints, the ochres, etc., it is not essential to have all the pigment oxide of iron, or the hydrated oxide of iron, which is the characteristic coloring matter of the ochre. A very large percentage may be inert material, and yet perfectly satisfactory results obtained. Not so, however, with colors to be used for coach painting. In these paints color is the thing desired, and from the necessities of the case, as has been explained above, each successive coat must necessarily be thin. If, therefore, the pigment is only one-third or one-half coloring matter, in any good paint to be used for coach painting, it is obvious that more coats will be required to get the same amount of color on the surface than if the pigment is largely, or, in fact, nearly all coloring matter. To give an illustration: if a sample of Tuscan red is 75 or 80 per cent. red oxide of iron and 15 per cent. organic coloring matter, three coats will give a fine body of color on a properly prepared surface. If, on the other hand, the same Tuscan red is mixed with one-half sulphate of lime, it will be found that three coats show a much less depth of color and a great tendency to streakiness. This we have actually found by experiment, so that the covering power of coach color is not wholly a question of thinness of the paint. Almost equally important, and perhaps more important, is the constitution of the pigment.

Accordingly, while, as will appear later in our specifications for paint to be used for house painting or analogous work, we allow large quantities of inert material, we do not, on the other hand, in our specifications for coach color, make any allowance for inert material, beyond the neces-



THE TOWER BRIDGE OVER THE THAMES, LONDON, ENGLAND.

sary impurities of commercial pigments. We have already been criticised somewhat by old coach painters for allowing too much inert material in our house-painting paints, and on the other hand some of the paint manufacturers who have been accustomed to use large quantities of inert material in their ready mixed paints, and only small amounts of color for tinting, think our specifications for coach paints altogether too severe in not allowing some chance for inert material. We are confident both these parties will ultimately approve our course before we finally finish with our discussion of the paint question, and we are likewise confident that both parties are right from their own standpoint. The difficulty arises in confounding the two kinds of painting—coach painting and house painting. A paint which will give perfectly satisfactory results when used for house painting, its appropriate method being used both in the preparation and application of the paint, will be worthless for a coach paint. On the other hand, a pigment that is valuable and in every sense satisfactory as a coach paint, although it would work well enough, and possibly give good results, when used for house painting is, nevertheless, very much more expensive than is necessary for a house paint, and will not, if our reasoning and experiments can be trusted, give any corresponding increased durability or benefit in keeping with the increased expense. No doubt this proposition will hardly be accepted by many old painters. We ask them, however, to hear us through and follow our reasoning and experiments before they finally condemn us.

In the next article we will speak of the drying of paint, and if space permits, of covering power.

(TO BE CONTINUED.)

THE TOWER BRIDGE AT LONDON.

THE accompanying illustration, which is taken from *Industries*, gives a general view of the Tower Bridge, which is now being constructed over the Thames River in London. The work was begun in 1885 and is now well advanced, although it has been delayed by many causes. The piers are now completed and the superstructure is being erected. The bridge is farther down the river than any of the existing bridges, and is at a point below many of the large wharves, so that it was necessary to provide passage for vessels of considerable size. A fixed low-level bridge was not possible. An ordinary low-level drawbridge would entail a total stoppage of traffic when the bridge was open, while a high-level bridge or a tunnel under the river would require approaches with such grades as to render the crossings practically useless.

The form of bridge ultimately decided upon, and which is now being carried out, will, it is thought, offer the minimum obstruction to the shipping interests, while at the same time it will provide in the best manner for the street traffic, especially for foot-passengers, who will be able to pass over the bridge at all times.

The distance between the North, or Middlesex, abutment, and the South, or Surrey, abutment, is 880 ft. Two massive masonry piers, each 70 ft. wide, have been built in the bed of the river, and have centers 270 ft. apart, so that the central or opening span is 200 ft. clear. The side or fixed spans are each 270 ft. clear. The total length of the whole bridge, including the necessary approaches on both sides of the river, is 2,640 ft. The roadway along the approaches and side spans will be 60 ft. wide, but over the central span it will be reduced to 50 ft. Nowhere will there be a steeper gradient than 1 in 40, which compares very favorably with London Bridge, where the gradient is in some places 1 in 27. Notwithstanding the very large piers necessary for this type of bridge, the sectional area of the waterway is 20,040 square feet, which is rather in excess of the dimensions at London Bridge, where the area is 19,300 square feet.

With the gradients above referred to, it is not possible to give greater head-room for vessels than 29 ft. 6 in. at high water, but this will be sufficient for the bulk of the river traffic. There are, however, on the average, some 22 vessels passing per day which require a much greater head room than 29 ft. 6 in., and for their benefit the cen-

tral span of the bridge will consist of two immense leaves, which will weigh nearly 1,000 tons each, and which will be so nicely balanced, that they may be easily rotated in a vertical plane by hydraulic machinery on the piers. When these leaves are raised into a vertical position, the headroom will be about 140 ft. for the clear width between the piers, which will be ample for all the vessels which navigate this part of the river. While the bridge remains thus open all vehicular traffic must be suspended, but in order not to interrupt foot-passengers crossing the bridge at all times, there will be provided two permanent gangways over the central span at a height of about 140 ft. above high water. These will be each about 12 ft. wide, and at each end there will be large hydraulic hoists for the convenience of people using these high-level footways.

The work was divided into seven sections and, as stated above, is now well advanced, in spite of many delays. In building the piers and approaches about 10,000 cub. yds. of stone and 70,000 cub. yds. of concrete were required, while in the superstructure about 15,000 tons of iron and steel will be used. The machinery for working the opening span and the passenger elevators in the piers will consist of eight hydraulic engines and four hydraulic lifts, with six accumulators and two steam pumping engines of 360 H.P. each.

The superstructure is almost entirely of steel, manufactured by different firms. The preparation and erection of this part of the work is under the charge of William Arroll & Company, of Glasgow, the general contractors. For the rolled steel a tensile strength of 27 to 32 tons per square inch is specified, with an elongation of at least 20 per cent. Siemens-Martin steel is used and careful tests are made of all the material. The Chief Engineer is J. Wolfe Barry, whose design is certainly striking and original. The bridge, it will be seen, consists practically of two separate stiffened truss suspension bridges, the central piers or towers being connected by a girder, which also forms the high-level crossing.

THE ACCIDENT TO THE SAULT CANAL LOCK.

(From the Cleveland *Marine Review.*)

COLUMN descriptions of the recent accident at the Sault Lock failed to describe intelligently the workings and machinery of that important gateway between Lake Superior and the lower lakes. At least, very few vessel owners, shippers, and marine men in general understood just where the trouble was. The *Review* gives detailed drawings showing the break, and adds others which illustrate the workings and plans of this lock, through which has passed during the last nine years $519,254,065 worth of freight, carried by 58,323 vessels, for which the lock was opened and closed 29,267 times. During 234 days of 1889, 9,579 boats, with tonnage of 7,221,935 tons, passed through this canal, while only 3,425 boats, with tonnage of 6,783,187, passed through the Suez Canal. Were all this traffic thrown on the lines of railroad, they would be hopelessly blockaded, and the retarded circulation of commerce resulting would more seriously affect the financial condition of the country than any one other feature of transportation.

Figs. 1 and 2 represent the north emptying valve beneath the lower gate, in a tunnel that extends from the well *Y* to the well *Z*, whence it discharges into the canal. This valve, as is shown in fig. 1, is in the tunnel midway between the wells, and almost directly under the miter-sill. It is 10 ft. wide by 8 ft. deep, and moves on a trunnion, which has bearings in a heavy iron frame bolted to the culvert or tunnel. The valve consists of a cast-iron frame covered with boiler-iron. Lugs from the valves attach to a pitman, connected with a piston-rod which is operated by water cylinders indicated by *L* in fig. 4. Water from an accumulator, with a cylinder 21×24 in. and capacity of 1,859 galls., may be admitted to either end of the 15-in. water-engine cylinders. This power is obtained from two 30-in. turbines geared to a main shaft, and fed through a supply pipe, *B C*, fig. 4, from the canal above the lock. A belt from the shaft runs two force-pumps, each having three plungers, which pump into an accumulator loaded so as to give a pressure of about 120 lbs. to the square inch. Water is taken from the accumulator to the engines operating the gates and valves.

As is shown in fig. 2, the trunnion to this valve, falling back under a pressure of 45 tons to position, twisted the connecting-rod of the water cylinder. The cap square was also broken, the breakage being attributed by some to

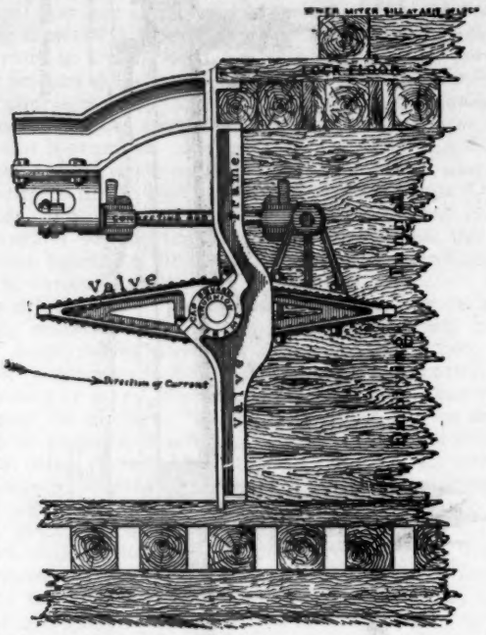


Fig. 1.

the jar caused by blasting with dynamite for the new lock. The gateway of the northwest was closed, the Colossus of Locks had closed business for a summer vacation, while 265 vessels, valued at $16,489,000, with $2,525,550 worth of cargo and 1,362 passengers lay motionless.

The diver secured the broken pieces of the trunnion, 6-in. hollow cast steel, over which a wrought-iron wrist

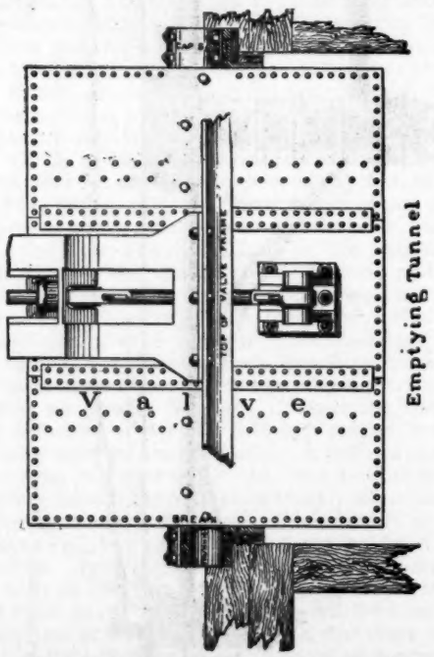


Fig. 2.

had been shrunk last winter. A piece of 4-in. steel was threaded, and an old cap square repaired, so that when the lock was pumped out the repairs were quickly made by putting the bar of steel through the hollow trunnion and bringing the broken parts together.

The repaired cap square was put on, the twisted connecting-rod was straightened, and the filling of the lock was all that was necessary for the delayed fleet to resume

movements, 81 vessels being locked through the second day that the canal resumed operations, 87 on the third day, and 85 on the fourth. The shock that probably caused the accident seemed to shake up the Northwestern railroad presidents and boards of trade until the influence was felt at Washington, so that amendments will likely be made to the River and Harbor Bill that will give $900,000 to the new lock and approaches for the coming year, and provide that contracts be entered into for the entire structure.

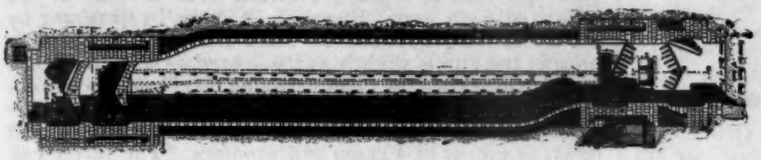


Fig. 3.

The lock in use at present was commenced in 1873, after plans advised by General Poe, and was completed in 1881. The chamber of the new lock is 515 ft. long, 80 ft. wide, except at the gates, where it is 60 ft., and the depth is 39½ ft. The lift of the lock is 18 ft. and the depth on the outer sills is from 16 to 17 ft. The protection built last winter for these sills could be seen when the lock was emptied to make repairs, and the torn bar-iron and scarred frames indicated the wisdom of its construction, although there was some objection to it at the time. A guard-gate at either end makes the extended walls 717 ft. long. They are 13 and 25 ft. wide at varying distances. About 35,000 barrels of cement and 34,207 cub. yds. of masonry were used in the walls. In the miter walls for the upper lock and guard-gates there are nine courses of cut stone, each 2 ft. thick. The walls are 14 ft. wide at the miter angle, are arched to resist the pressure on the gates, and are bonded into the lock walls. The top course of stone is set back 1 ft., so as to leave an offset, on which the oak miter sills rest; these sills project 2 in. above the masonry.

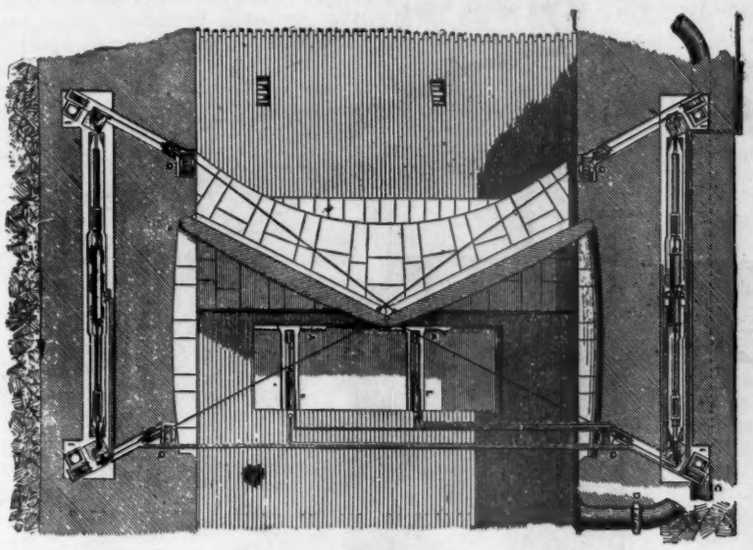


Fig. 4.

The foundation is on rock throughout. In excavating the lock pit, rock was reached at from 1 to 15 ft. above the grade of the lock floor. A floor of timber and concrete extends across the bottom of the lock and 5 ft. under each wall; the rest of the wall foundation is concrete, 6 in. to 2 ft. thick on the rock. All the foundation timbers are of pine, 1 ft. thick. The miter sills are of oak 12×18 in., and are held in place by bolts 10 ft. long, fox-wedged and concreted in the rock, and also by timber braces bolted to the rock.

The four gates, two being guard-gates used only in case of accident and for repairs, are shown by *P Q R S* in fig. 3. The weight of one leaf of the upper gate is 40 tons, while a leaf of the lower gate weighs 76 tons, being made of white oak and Norway pine. The position of the four gate engines, which are operated by water taken from the accumulator, are shown by *J J J J* in fig. 3. Each cross-head is constructed with two sheaves. One end of a wire rope is adjustably fastened at *I*, fig. 4, and, passing around one of the engine sheaves, is led by suitably located sheaves down through the well in the lock wall, around the drum *Q*, and to a leaf, to which it is secured. The four ropes necessary for the opening and closing of each gate are clearly shown in fig. 4. When the engine makes a stroke, the end of the rope attached to the gate moves four times as far. With a pressure of 200 lbs. per sq. in., the total pull on the leaf of the gate is 8,835 lbs., less friction and rigidity of rope. In case the gates should be carried away, provision has been made by means of a movable dam 3,000 ft. above the locks, for the closing of the guard-gates.

Water is let into the locks from culverts under the floor, extending from the well *X*, fig. 3, above the upper lock gate, to the well *Y*, above the lower lock gate. The two culverts are separated by a longitudinal bulkhead, and each is 8 ft. square. The floor of the lock forms the roof of the culverts. The water passes into the lock chamber through 58 apertures in the floor, shown in fig. 3. The total area of these apertures is 174 sq. ft.; this outlet area is increased to 190 sq. ft. by man-holes left in the bulkhead at the lower end of the culverts. The combined area of the cross-sections of the two culverts is 128 sq. ft. Having the inlet area considerably less than that of the outlet tends to diminish the velocity of the water when projected upward into the lock chamber. The water in passing out of the lock goes down through the well *Y*, which, as well as the well *X*, is covered with a grating, thence through short culverts, and up through the well *Z*. The valves in the culvert through which the water enters are the same as the discharge culvert valves already described.

The first lock was constructed during 1853, 1854 and 1855 by the State of Michigan, to which Congress made a grant of 750,000 acres of land for the purpose. Previous to 1845, several brigs in the fur trade were the sum total of the fleet on Lake Superior; but the discovery of copper made the portage of the Sault Rapids an important one, and with the discovery of iron ore came demands for the canal—the first ship canal in the United States, and at that time the largest in the world. The Sault Rapids, which have made the canal and lock necessary to lake navigation, are one-half mile long, and have a fall of about 17 ft., the fall from Lake Superior to the Sault being one-tenth of a foot, and thence to Lake Huron about 2 ft. For a few years vessels were transported on ways to the head of the rapids, and then relaunched, and for a short time a horse tramway did an extensive business between the foot and head of the rapids. The first canal cost $1,000,000, and was 5,400 ft. long, 100 ft. wide and 12 ft. deep. The present canal, with a depth of 16 ft., was completed but a short time when the increase of commerce demanded greater facilities, and the work of making a channel 20 ft. deep was undertaken. It consists of the construction of a new lock on the site of the old State locks, to be 800 ft. long, 100 ft. wide and 21 ft. on the miter sill. This will enable shipbuilders to design boats on lines which are known to give the greatest carrying capacity, while at present they are hampered by making ships comply with the narrow depth. The estimated cost of the new lock and improvement is $4,738,865. One million has been appropriated, and up to June 30, 1889, $250,331 had been expended, and the remainder of the appropriation was covered by contracts. The lock in use at present cost $2,404,124. The cuts are from drawings furnished by Colonel O. M. Poe, U. S. Engineers.

THE DEVELOPMENT OF ARMOR.

By First Lieutenant Joseph M. Califf, Third U. S. Artillery.

(Copyright, 1889, by M. N. Forney.)

(*Continued from page 412.*)

XVIII.—THE SCHUMANN-GRÜSON CUPOLA.

In the Grüson system, previously explained, chilled cast-iron alone is used. To be effective, however, cast-iron has to be employed in very heavy masses, which precludes its use in cases where moderate weight and ease of manipula-ipulation are requisites. Wrought-iron largely, and steel to a less extent, have been used in armored forts and batteries. To some extent compound plate has been employed, but the difficulty of curving a plate of this character without destroying the union between the hard face and soft iron back is a serious obstacle to its use. It is believed to be a safe prediction that cast-iron and steel will be the metal chiefly employed in the armored fortifications of the future.

The Schumann-Grüson or German cupola was designed by Major Schumann, of the Prussian Engineers, and manufactured by the firm of Grüson, of Bockau. While externally presenting much the same appearance of the Grüson cast-iron cupola, it differs from it in several important particulars. Fig. 1 gives a general idea of the structure, which consists of two principal parts—(1) a fixed outer glacis ring of chilled iron blocks or segments, and (2) of a curved umbrella-shaped oscillating shield, made up of six segmental side and two hexagonal roof-plates, each 8 inches in thickness.

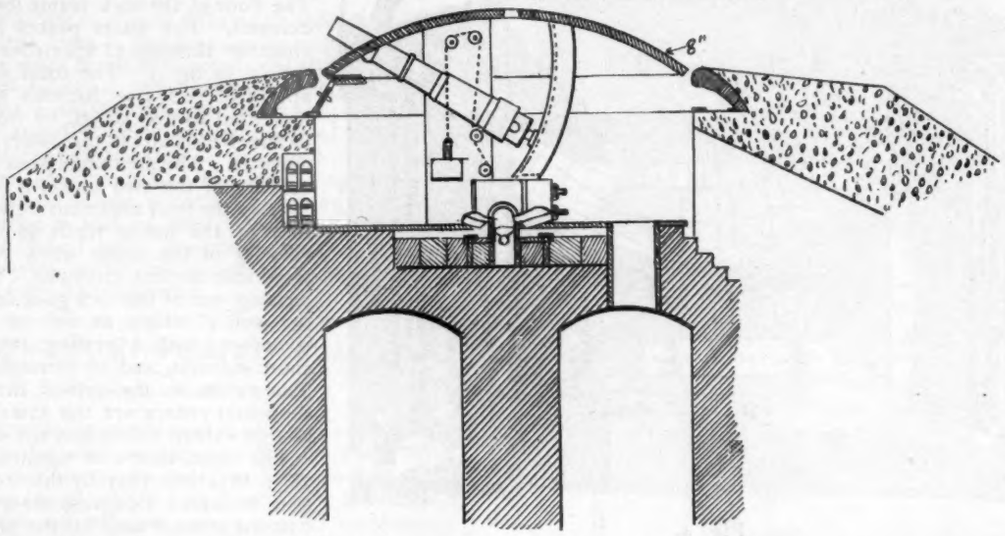


Fig. 1.

The glacis ring is set in concrete, which protects the turret proper from its base up to the height of the gun ports, and is itself protected by a concrete slope 9 ft. in thickness. In the first experimental cupola constructed upon this plan, half of the segments of the turret were of wrought-iron, the remainder of compound plate. The behavior of the compound plate under fire was so unsatisfactory that its use is believed to have been abandoned in this system.

The shield does not permanently rest upon the glacis ring, but its entire weight is taken on an 8-in. central pivot. By means of a socket piece, collar and gearing the shield can be raised or lowered about 6 in., allowing it to rest upon the glacis ring or raised from it when in the firing position. The whole structure is free to oscillate on the rounded head of the pivot. To take up the force of recoil of the guns, as well as that from the blows of projectiles, the lower edge of the shield is provided with legs set in journal boxes and having strong volute springs. These legs rest on trucks running on circular roller-paths fixed to the inner top angle of the glacis wall.

The two guns are mounted side by side, and, by means of rings carrying trunnions shrunk on near the muzzle, are pivoted in recesses formed in the inner skin at the sides of the ports. The force of recoil is transmitted to the structure by means of a pair of vertical arcs in rear of the breech of each gun. Elevation is given by quadrant by the aid of the gradations on these arcs. The preponderance of the gun is slightly overbalanced by a counterpoise weight suspended by chains passing over pulleys and attached to a crossbar passing under the gun in front of the breech mechanism. To give elevation the breech is hauled down by means of a chain and windlass. The turret can be rotated by means of pinion gearing actuated by winch handles. Through the top and in rear of the center of the shield is a hole sufficiently large to admit the head of the man who sights the guns, to which access is had by a light iron ladder.

The central idea of the Schumann cupola is that the guns, shield and gearing are rigidly connected, and that the entire force of recoil shall be absorbed in the oscillation of the whole mass.

The pit is a single circular chamber 19.5 ft. in diameter walled with brick, with its floor-level about 3 ft. below the natural surface of the ground.

Major Schumann is also the designer of many of the defensive structures made by the firm of Grüson, which are being largely adopted by the Continental powers. In addition to the one already described there is a disappearing cupola for a 12-cm. gun—the heaviest ordnance, the designer holds, that should be mounted in such a structure; disappearing cupola for quick-firing guns; traveling shield for light guns, and a spherical shield for mortars, all of wrought-iron, except the first, which is of steel. In addition, he has designed an elaborate fortification or battery, consisting of a central disappearing cupola, with an auxiliary defense of ditches, abattis, quick-firing guns and mortars.

During the manœuvers of the German army last year the position taken up by the defensive portion of the troops was strengthened by eight Schumann iron-clad towers, armed with quick-firing guns. These towers or shields were simply small revolving turrets, resembling beehives in outward appearance, mounted on wheels, and, in the absence of horses, were drawn by soldiers, and each manned by two artillerymen. The shields were of 1½-in. steel, and supposed to be bullet and splinter proof.

XIX.—THE FRENCH OR MOUGIN TURRET.

This turret, designed by Major Mougin, of the French army, and manufactured by the Saint-Chamond Company, Loire, is shown in fig. 2. Like the Schumann-Grüson turret, just described, the armored portion of the structure consists of two parts—the glacis-ring and the turret proper.

These are contained in two circular chambers, one above the other, the upper one, containing the guns, being on the natural level of the ground, the lower one the hydraulic pivot. The glacis-plates, of the form shown, are of cast-iron, set in concrete, and protected in front by a mass of the same material.

The turret proper is of wrought-iron 18 in. in thickness and with an exterior diameter of 15.7 ft. The top is closed by a 7.2-in. wrought-iron plate, in two sections, mortised together, and is let into rabbets in the walls and secured by screw bolts. The turret is mounted upon what is called a "floating pivot." It rests upon a built-up annular box girder, which in turn is secured by means of brackets to a heavy casting that rests upon a 10½-in. steel pivot, about which the turret revolves. This pivot rests in a steel-lined cast iron cylinder containing glycerine, which supports the entire weight of the structure—something over 100 tons. By means of a hand pump the whole movable portion of the turret can be raised so that little or no weight rests upon the rollers.

The turret is revolved by means of a double-purchase winch in the lower chamber. Horizontal and vertical rollers, upon a track of cast-iron bolted to the top of the pit wall guide and control the motion of the turret, but do not support its weight.

The two guns are mounted side by side, and to facilitate manœuvring, are each provided with a counterpoise weight

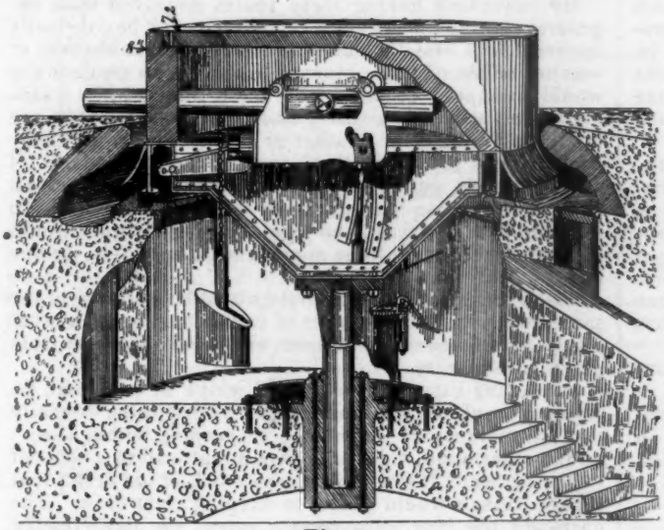


Fig. 2.

suspended in front of the central pivot, but having a preponderance of 1,100 pounds. The recoil is taken up by means of small hydraulic cylinders under the gun, one above the other, the piston in the upper cylinder being connected with the carriage. The opening between the cylinders is closed by a one-way valve which opens automatically during recoil, the force of which is made to compress a strong spring. By opening this valve the spring is released and the gun run into battery.

Excepting the gun-ports, there are no openings of any kind on the side toward the enemy, a door affording ingress and egress from the rear. Except the view obtained through the bore of the piece, the gunner has no means of knowing the character or position of the object aimed at other than from information received from the observing station some distance away. The guns have no sights; the elevation is given by quadrant. By means of a metal ring, graduated to degrees and quarters, the guns can be laid according to directions received from the operating station by telephone or otherwise. It is intended that the guns shall be fired by electricity and automatically. Movable contact-pieces, which may be clamped at any desired point on the pointing arc, are made to close a circuit and fire the piece. It would seem that the perfect immunity from rapid and machine-gun fire afforded by the properly closed turret is too dearly purchased when it deprives the officer in actual charge of the guns of any intelligent idea of the results of his fire, and makes him absolutely dependent upon exterior means and material which at any moment may become disabled.

In a turret of later design, Major Mougin employs a mushroom-shaped dome in place of the cylindrical turret, with interior fittings almost identical with those employed in the latter.

A disappearing turret has likewise been designed in which the cylindrical form has been adopted, the material to be steel-faced plates and the roof in one piece. The base is supported on the piston of an hydraulic press, which also serves as the pivot for the turret. No rollers are employed, the center of gravity of the structure falling well over the pivot. The turret has a vertical motion of one meter.

The certainty that high explosives will be used in the next great war has, in France, led to a new departure in the construction of defensive works. Major Mougin has designed a fort which is little else than a huge block of concrete, on the top of which are three cupolas, each mounting two 6-in. guns. Instead of soldiers, this peculiar structure is to be garrisoned by 30 or 40 skilled mechanics. Entrance is obtained only by a subterranean gate. To assist in the defense a double line of railroad, covered by a parapet, encircles the work, upon which trucks carrying guns can run, making it possible to reinforce, with this movable armament, any particular point of the work.

Two years ago some experiments were made at Chalons with a view of testing the merits of two truck turrets, used in connection with concrete glacis. The one, the Saint Chamond or Mougin turret, already described, and the other manufactured by the well-known Chantillon & Commentry Company. The latter made an important improvement upon the rotary Saint-Chamond turret, in adding to the rotary motion an ellipse movement, so that the turret not only turns on itself, but, by a simple counterpoise mechanism, drops down after firing, projecting then above the ground only about 6 in. These ellipse turrets are to be of cast steel, have a thickness of 50 cm. and each to weigh from 120 to 190 tons.

In carrying out these experiments the plan adopted was to divide them into two parts, first to fire from the turrets to test the turret mechanism, carriages and system of mounting, and afterward to subject the turrets themselves to cannonading. No professional reports of these experiments are at hand, but from the newspaper accounts it would appear that during the first series the turrets behaved exceedingly well, but that when subjected to fire the results were by no means as satisfactory, the turrets being badly shattered, and even the concrete failing to display the resistance expected of it.

XX.—THE BUCHAREST TRIALS OF ARMORED TURRETS.

During December and January, 1885–86, a series of trials was conducted near Bucharest to test the relative merits of the German and French turrets for land defense. This was done in view of the fact that the Roumanian Government had in contemplation the building of an extensive line of iron clad forts for the protection of its capital.

A Schumann cupola and a French cylindrical turret, constructed upon the lines given above, were erected, the former armed with 15-cm. Krupp, and the latter with 15-5-cm. guns, or both practically of 6-in. caliber. It was designed to test the turret mechanism by firing guns from the turret and the armor-plate by firing at it, thus bringing the experiment down to actual service conditions, subjecting both as nearly as possible to the same stress. The projectiles used were steel shell and the distances 1,000 to 300 meters.

From the German cupola 100 rounds were first fired, during which the turning and other gear worked satisfactorily, and finally, after the structure had been subjected to fire, 50 more rounds were fired at extreme elevation without injury to the mechanism. In the attack the cupola received 85 direct and 12 ricochet hits. Three of the six segments were of Wilson's steel-faced plate, the other three of wrought-iron. The effect upon the compound plates was

to crack the hard steel face, and ultimately to peel it off completely in places from the wrought-iron backing, practically breaking the plate. Against the wrought-iron plate the effect was insignificant, and limited to scooping out of the metal, without starting cracks or opening welds. Four effective hits were obtained upon the roof plate of wrought-iron, from a 21-cm. rifled mortar, firing a 176-lb. shell, producing only slight indents.

Against the French turret, which, it will be remembered, was of 18-in. wrought-iron, 63 direct and 9 ricochet hits were obtained. When the blow was delivered normal to the surface, the steel shell had a maximum penetration of about 9 in., and rebounded without great deformation; glancing blows simply gouged out a little of the metal. By concentrating the fire upon a small space the turret was practically breeched near the junction of the side and roof plates, but without materially injuring the interior or gear, or interfering with rotation.

Comparing the two systems, it was found that the springs in the guiding tracks of the German turret received a permanent set, and that the cupola at the end of the trial had a cant to the rear, arising from the fact that the guns being pivoted in the shield, the blows of recoil were always delivered in the same direction, and that the edges of the shield were not sufficiently protected. On the other hand, the umbrella shape of the German cupola was vastly in its favor, and it was found that its 8-in. plate, against which it was almost impossible to deliver a square blow, was practically about equal to the 18 in. of the French cylindrical turret, while at the same time the cupola presented a smaller and much less conspicuous target. In ventilation, lighting and methods of laying the guns, the German system was believed to be superior, while in ease of traversing, in the mounting, and in rapidity of fire the French was the better one.

The Commission appointed by the Roumanian Government to superintend these trials reported in favor of Schumann-Grüson system, and upon this system the defense of the capital will be constructed. It should be said in connection with these experiments, that with the light charges and projectiles used the energy obtained from the 6-in. guns mounted in the turrets was greatly inferior to what might be expected from the siege guns of any first-class power.

It may be of interest to add that the last of the 18 iron-clad forts for the defense of the Roumanian capital is about completed. These forts are three miles apart, some 10 miles from the city, are in a circle nearly 50 miles in circumference, and are connected by a railroad, wagon roads and telegraph. The armament is of Krupp guns.

(TO BE CONTINUED.)

STEAM LANES ACROSS THE ATLANTIC.

BY LIEUTENANT HENRY H. BARROLL, U. S. N.

IN 1855 the principal ship-owners, underwriters and merchants of Boston addressed a letter to Lieutenant M. F. Maury, U. S. N., at that time in charge of the Naval Observatory, and asked that he would consider the adoption of separate routes or "lanes" across the Atlantic, between Europe and American ports North of Cape Hatteras, by following which lanes steamers might diminish the chances of collision.

Among the signers of this letter were Messrs. John S. Sleeper, C. W. Cartwright, J. Ingersoll Bowditch, and Mr. R. B. Forbes, the latter gentleman being accredited by Lieutenant Maury with having originated the idea of this system of routes.

Maury carefully studied the subject and made a comprehensive reply, accompanying it with maps, showing where, in his opinion, the lanes should be located.

In his investigation he consulted the log-books of the Collins (American) and Cunard (English) lines of steamers. He found that along that part of the route extending between the meridians of 15° W. and 65° W. the American vessels, in their voyages to and fro, made use from time to time of a breadth of ocean 300 miles in width, while that of the English line was only 150 miles. The American route overlapped and included that of the English vessels.

There was, consequently, a belt 300 miles wide extending between these longitudes, in any part of which a sailing vessel was either at night, or in a fog, liable to come in collision with a steamer; while steamers were also liable to collide with each other.

Maury's conclusions and suggestions were largely based upon the strength and direction of the prevailing winds and currents, which at that day bore a much more important part with regard to steam navigation than they do at present. A summary of his reply to the above-mentioned letter is as follows:

He suggested that there should be designated a "Lane" or band 20 or 25 miles in width near the northern boundary of this 300-mile strip, and another 15 or 20-mile band near the southern border, and recommended that easterly bound steamers agree to use the southern, and westerly bound steamers the northern of these routes. This would greatly diminish the chances of collisions, while it would not add materially to the length of the voyage. He plainly demonstrated that, by adhering as closely as possible to these routes, vessels would derive the most advantage from the set of the Gulf Stream on the eastern route, and avoid its resisting force when coming westward.

He advocated having these routes engraved upon the general charts of the Atlantic, thereby letting it be constantly apparent by a vessel's plotted position whether she was or was not in one of these lanes. If she were a steamer she would attempt to remain within these limits, while a sailing vessel, although possibly finding it convenient to use the lanes during clear weather or by daylight, could easily edge away at the approach of night or thick weather. If sailing vessels during night or in foggy weather found it to their interest to cross these lanes, they would do so as rapidly as possible, and while in these limits would know that all danger to be apprehended would be in one certain direction.

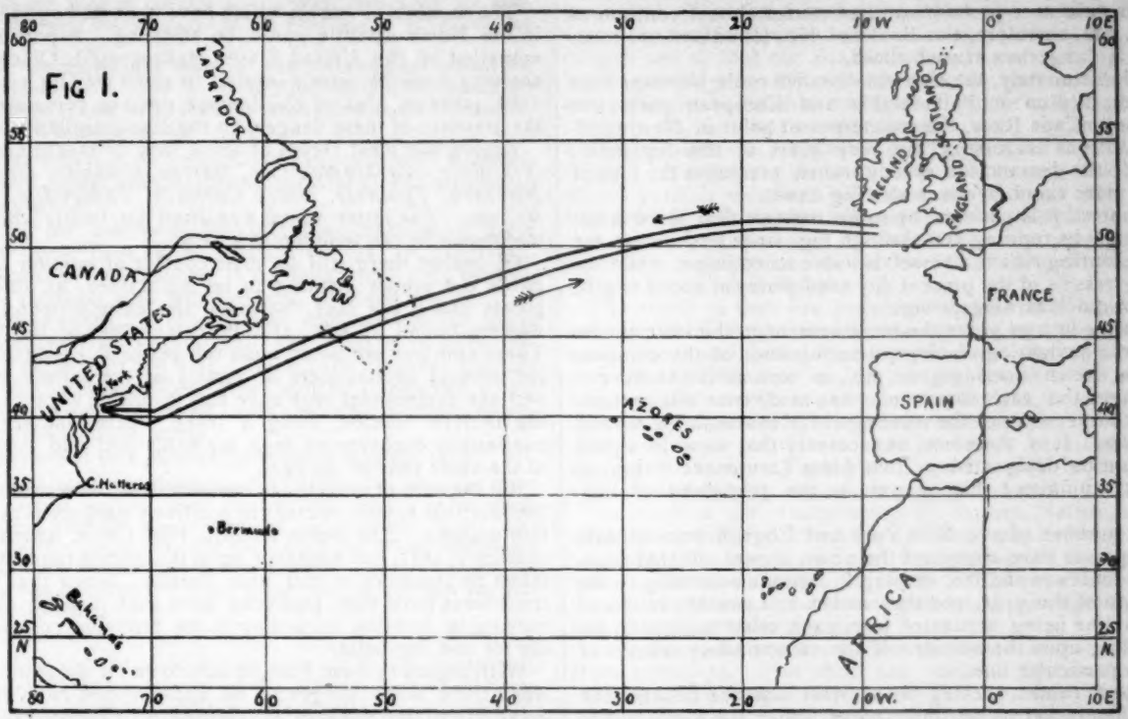
As all steamers in either route would be standing in the same direction, their chances of colliding with each other would be reduced to a minimum, and could only occur from gross carelessness.

Lanes any narrower than those which he proposed, he claimed, would be disadvantageous, owing to the difficulty that steamers would experience in keeping within them; on the other hand, a broader lane might lead to a want of vigilance, while it would occupy so much of the ocean that sailing vessels would object to keeping clear of it. The narrower the lane, to a certain extent, the more readily would sailing vessels keep clear of it, since they could the more quickly pass through it if occasion demanded this; while from its narrowness sailing vessels would know that the liability of meeting steamers in those limits would be greater than in a broader pathway.

Much of the reply was devoted to a description of the Banks of Newfoundland, and showing how these shoal banks would assist masters of vessels, even in thick weather, in keeping within the designated lines. Lieutenant Maury says:

> You will observe by looking at this lane (fig. 1) that the Grand Banks afford a pretty good landmark, which can be used in the thickest weather. Generally the water thermometer is found to fall as soon as you near these banks. The eastern edge runs north and south, and therefore affords an excellent correction for longitude. Having ascertained by the lead when the vessel first strikes this edge, then noting the soundings and the distance run before clearing the Grand Bank, the latitude will also be known with accuracy sufficient to enable the navigator to decide whether he be in or out of the lane, and if out, on which side.
>
> The lane crosses the Banks near their greatest width, 275 miles. If a steamer be crossing there in a fog, and in doubt as to her position, she can judge by their breadth and the sounding pretty nearly as to the latitude. For instance, if the breadth of the Banks when crossed be less than 275 miles, but the soundings not less than 40 fathoms, the vessel has crossed the Banks to the north of the lane. But if she find herself in

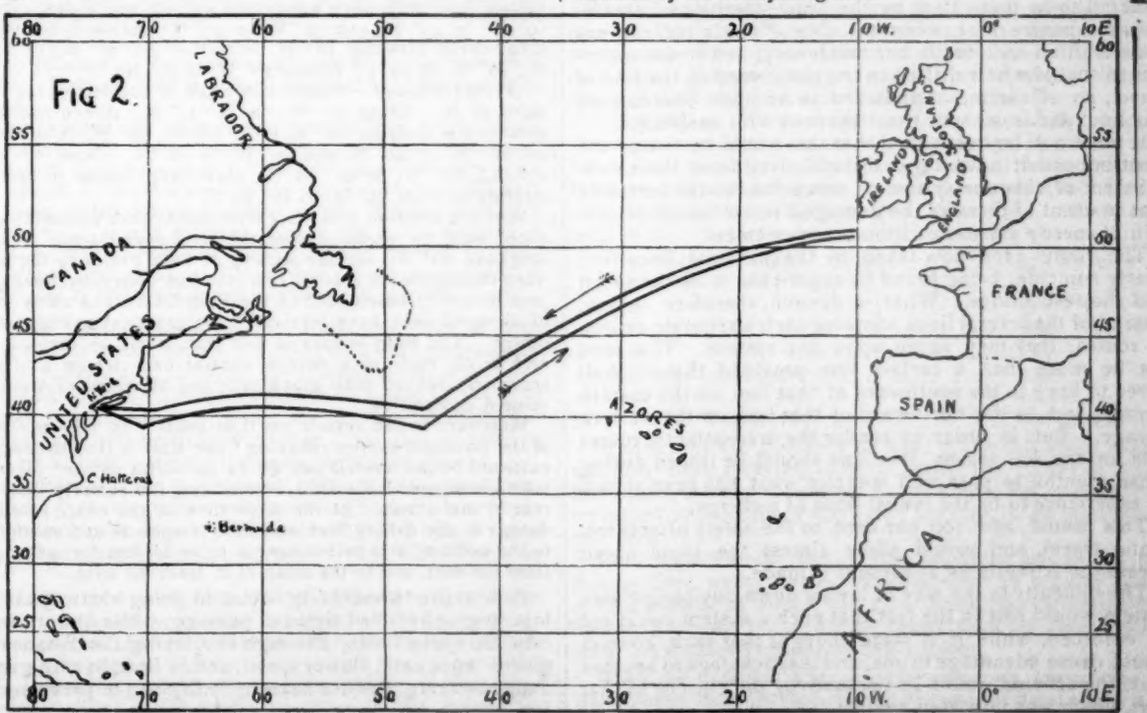
less than 30 fathoms, then she has crossed to the south of it. Should she, however, find herself in water that suddenly shoals to less than 20 fathoms and as suddenly deepens again, then she is near the Virgin Rocks, or the rock and Nine Fathom Bank to the east of them, and her position is immediately known.



It should be recollected, however, that these lanes are not channel-ways in which steamers must keep or be lost. Gales of wind, ice, and other things, will now and then force a steamer out of them, and in such cases she will be just where she is now, for she will then be in no more danger than at present.

It may be urged against this lane that it cannot always be followed on account of the ice, and that inasmuch as it crosses the Grand Banks, the steamers that ply in it may now and then run down a fishing vessel. The reply is, that as far as the fishermen are concerned, they are now liable to be run down by steamers both going and coming; whereas, with the lanes that liability is incident to the steamers alone that are westerly bound, and the fishermen will have the advantage of knowing pretty nearly where the steamer will pass, and which way she will be coming.

And as for its being obstructed by ice, so as to compel the steamers, as it occasionally will, especially in May or June, to turn out of it now and then, the Erie Canal of New York is obstructed by ice the whole of every winter, but that does not prove it to be of no value; it only shows that it, like this lane, would be of more value to commerce if it were never obstructed by ice or anything at all.



Although the routes, as recommended by Maury, and shown in fig. 1, are at certain months advantageous, yet we now know, in the light of later experience, that it is not expedient to pursue them during certain seasons of the year. The great danger to be apprehended is the collision

with icebergs, derelicts, or other vessels, while running through the fog-belt which is almost constantly found on the Newfoundland Banks during the ice season.

In the vicinity of Virgin Rocks and Flemish Cap, the cold Polar Current, bearing hundreds of icebergs broken from arctic glaciers, meets the warmer waters of the Gulf Stream. This difference in temperatures causes almost continuous fog, and, therefore, the Banks of Newfoundland are especially dangerous at such times.

Unfortunately, the shortest-distance route between New York, Boston or Philadelphia and European ports lies close to Cape Race, the southernmost point of Newfoundland, thus traversing the very heart of this fog-bank; while the demand for speedy transit precludes the idea of the more rapid steamers slowing down.

Indeed, it is claimed by some masters that there is advantage in running fast through fog, since it shortens the time during which a vessel is liable to collision, while the long vessels of the present day need plenty of speed to give them quick turning power.

In the last 30 years the improvement in the instruments for the navigating of ships, determination of the compass error, steam steering gear, etc., as well as the number of voyages that each commander has made over this particular course, enables the steering of the course to the nearest degree. It is, therefore, unnecessary that so wide a path should be designated as that when Lieutenant Maury, in 1855, submitted his answer to the gentlemen of Boston.

A number of the New York and English transatlantic companies have already of their own accord adopted separate routes to and fro, varying in latitude according to the season of the year, and the eastern and western routes of each line being separated from each other a distance depending upon the opinions of the commanding officers of each particular line.

These routes, seeking the shortest distance between the two hemispheres, naturally cover about the same belt of ocean; and with a little co operation among the several steamship lines which have already adopted separate routes, a single pair could be agreed upon that would be practically a steam lane across the Atlantic.

Although these lanes are not compulsory, yet they are adhered to to that extent by the above-mentioned steamship companies that, when the *City of Paris* recently encountered an accident to her machinery, and it was ascertained that she had drifted to the northward of the line of travel, an officer was despatched in an open boat to seek this line, and in a short time returned with assistance.

It must not be overlooked that this would be one of the most important advantages to be derived from the establishment of this one system of steam lanes—the certainty that in event of disaster the damaged vessel would be certain of speedy assistance from other steamers.

The routes even now taken by the principal lines very nearly coincide, being found by experience to be the safest and shortest routes. What is desired, therefore, is that, instead of the several lines adopting each a separate system of routes, they may agree upon one system. This need not be more than a certain line, provided that all shall agree to keep to the southward of that line on the eastern voyage, and to the northward of that line on the western voyage. But, in order to render the transatlantic routes safe in the ice season, this line should be traced during those months to pass well south of what has been shown by experience to be the lowest limit of icebergs.

This would add 100 per cent. to the safety of transatlantic travel, and would allow almost the same speed across the Atlantic as at present is made.

The difficulty in the way of laying down any compulsory system would rest in the fact that such a system could not be enforced, while if it were thought that such courses would cause advantage to one, and disadvantage to another port, the scheme would be opposed by the citizens of that port which was militated against.

Notwithstanding the discrimination, however, which might occur between ports situated on the same side of the Atlantic by this adoption of steam lanes, yet there could be no disadvantage to any one of the several lines running into the same port, New York, for example, in using such precaution, while it would greatly enhance the safety of the travelers, shippers and underwriters of that port.

It has been clearly proven that vessels which persistently use, during the ice season, that route which is known to be endangered by the presence of icebergs and fog-banks, sooner or later encounter disaster.

The number of vessels which have been damaged by ice in the North Atlantic would be startling. A partial list compiled by the United States Hydrographic Office, and showing some 60 vessels injured in some way by ice since 1882, gives an idea of the damage done to commerce by the presence of these dangers on the Newfoundland Banks.

Among the most recent of these may be mentioned the *Nessmore*, *Washington City*, *Mareca*, *Miranda*, *Minister Maybach*, *Tynedale*, *North Cambria*, *Thingvalla*, *Portia*, etc. The latter vessel was lifted up bodily while in mid-ocean by the toppling of a berg.

Of course there will be some conflict of opinion as regards the proper distance to be maintained, at different points along the lane, between the eastern-bound and western-bound vessels, at different seasons of the year. These opinions are based upon the personal experience of the several commanders of vessels of the various lines; and one commander *may* have had favorable voyages during certain months, along a track where another has continually encountered fogs, ice-fields and bad weather, at the same time of the year.

But masters of vessels are comparatively in accord as to the fact that certain routes are positively dangerous at certain seasons. The North Atlantic Pilot Chart, issued December 1, 1887, had engraven upon it separate routes to be taken by steamers to and from Europe. Since that time these lines have been produced upon each monthly chart, varying in location according to the probable position of the ice and fog-belts.

With regard to these lines, as laid down for those months when there is no danger to be apprehended from ice, I quote from the remarks of Lieutenant Everett Hayden, U. S. N., made on this subject before the United States Naval Institute:

Eastward bound.—Follow this track or nothing to the *northward* of it. Leaving New York, steer for latitude 40° 26′ N., and longitude 73° 46′ W. Thence E.S.E. ½ E., to the 100 fathom line, then deep soundings and off soundings, crossing 60° W. in 42° N. and 50° W. in 45° N., thence following the great circle, crossing 40° W. in 48° 01′ N., 30° W. in 49° 56′ N., 20° W. in 50° 55′ N. and 10° W. in 51° N.

Westward bound.—Follow this track or nothing to the *southward* of it. Cross 10° W. in 51° 10′ N., thence follow the great circle, crossing 20° W. in 51° 16′ N., 30° W. in 50° 28′ N., 40° W. in 48° 46′ N. and 50° W. in 46° N. Cross 60° W. in 43° N., 69° W. in 40° 38′ N., then keep inside 30 fathoms, steering to cross 74° W. in 40° 30′ N.

With the addition of a route from the English Channel (course about west by north), joining the west-bound route in about longitude 20° W., and the shifting of both routes to the southward during the ice season, this plan has been consistently and persistently recommended on the Pilot Chart, and many letters of approval have been received from practical navigators and others. The main feature of this plan, it will be noticed, is to *keep to the right* of a narrow central belt, whose limits are accurately defined both graphically and by means of a detailed printed description.

Westward-bound vessels are thus enabled to take advantage of the Labrador current, shaving Cape Race if they choose, and eastward-bound vessels can go as far south as they please to take advantage of the Gulf Stream and the easterly drift current in mid-ocean. At the same time in the central belt the danger to the fishing fleet and other vessels is at a minimum; to the north of this belt danger is to be looked for, principally from the east, and to the south of it, from the west.

Adherence to southerly routes in going eastward is certain to give reduced times of passage, while a more northerly European route, although shortening the distance, requires more care, slower speed, and is fraught with greater danger during the ice season, owing to the prevalence of fog.

In a letter on this subject to the Maritime Conference, recently held in Washington, Mr. C. A. Griscom, President of the International Navigation Company, says:

There can be no doubt that the risk of collision is the principal danger to be apprehended in the navigation of modern

steamships, and no one thing will contribute more to lessen this risk than the establishment of lane routes in the now already crowded North Atlantic.

My own view is that the lanes we have adopted are the most prudent, viz., to keep south of 42°, when crossing the meridian of 50°, from February 15 to August 15, and a safe distance south of the Virgins the rest of the year, separating the east-bound and west-bound tracks at the meridian of 50° about one degree.

While we pursue this practice with the steamers under our management—some 26—the good effect thereof is, of course, almost negative so far as the lane feature is concerned, because the practice is not general.

It would, in fact, be impossible to organize such a system of routes except voluntarily on the part of the steamship companies.

During the months of May and June especially a route further north than 41° N. latitude and 48° W. longitude, will sooner or later, owing to the fogs which here prevail, lead to collision with ice, derelicts, or other vessels.

There is very little gain in time compared to the great risk that the transatlantic mail has to undergo when following other than the safest route; the contract for carrying the mails should be given only to companies which guaranteed to follow at all times the safest, and not necessarily the speediest, route.

In regard to this subject Lieutenant Hayden says:

Another important element is the fact that the mails are given to the fastest vessels. One steamer may take a safer route, traverse a slightly longer distance, and lose the mail. This very thing happened only last year, when the *Werra* was beaten a few hours by the *Servia*, and Captain Bussius complained that he had followed the route recommended and lost the mail in consequence.

It is gratifying in the extreme, however, to be able to record that, notwithstanding the loss of the mail contract, the intelligent commander of the *Werra*, instead of being deterred from doing what he manifestly knew to be his duty, gives later to the Maritime Conference this expression of his opinion:

I would say that in the vicinity of Long Island, Nantucket and St. George's shoal grounds, I think it absolutely necessary to establish lanes for steamships apart. This can be done very easily, even if astronomic observations are not at hand, and the position of a ship is doubtful.

A westward-bound ship to keep north—that means, on 40 or 35 or 30 fathoms of water by soundings, when thick weather prevails. Here the ship will find pilots, as their position is in this line.

An eastward-bound ship ought to steer from Sandy Hook east by south, one quarter south, to the 90-fathom soundings, then east on deep soundings. This will cause steamers to go safely almost 50 degrees west, if the eastward-bound steamers keep warm water during summer, or, say, in latitude 41°. I have proved it dozens of times, that in summer a distance of 80 to 90 miles is gained eastward by the Gulf Stream between Sandy Hook and Scilly, if I kept well to the southward. I shall not fail to run these southern routes this summer.

It would be hard to find a more efficient class of men than the officers and crews of the transatlantic steamships. Much is expected of them by their companies, who have committed to their keeping millions of dollars' worth of property and thousands of lives; and it is due to their skill and untiring, unremitting vigilance, that the number of collisions are not yearly, thousands instead of dozens.

But of what avail is the greatest efficiency and the utmost vigilance, if at any time some towering iceberg looms up through the dense fog, at a distance of 500 yards, in front of an ocean greyhound going at the rate of 20 knots an hour?

A steamer of 10,000 tons, going at the rate of 20 knots per hour, would strike with an energy of about 40,000,000,000 foot-pounds, and there would not be enough of her left to make a horseshoe nail.

At present the great desire to lower the time of passage between Europe and America—to "break the record"—has a charm which few of the citizens of either hemisphere can resist.

Regardless of the danger to be encountered, and actuated by the desire to render a certain line, or even a particular ship, famous, masters will drive these splendid steamers through dense fog-banks, day and night, at a speed of 20 or 21 knots (24 or 25 miles) per hour, along a track known to be beset with thousands of dangers.

The great mass of travelers are ignorant of the fearful risks which surround them under such circumstances, and rest contented in the assurance that the greatest care will be taken. The vessel rushes madly along; well-trained eyes are continually strained to detect the first sign of danger, and all that can add to the security of the ship, so far as intelligence and watchfulness, on that course, is being exercised; but that she does not collide with some of the icebergs, derelicts or other vessels along the route is, in many cases, to be ascribed to good luck rather than carefulness. It is impossible to exercise care at such a rate of speed in thick weather. Choosing the shortest line between the two ports, she adheres as strictly as possible to this course, just as though she were the only vessel upon the ocean, regardless of the fact that this is also the shortest line for all other vessels.

The result is that she possibly "breaks the record," and arrives off Sandy Hook in six minutes less time than some other vessel has previously done the distance, or—perhaps she strikes an iceberg or derelict, in which case nothing is left of vessel, passengers or freight, except bills of lading, freight receipts and insurance policies.

Possibly some months later a boat may be picked up marked *Erin*, or a back-board, upon which is carved *City of Boston;* but such finds are not frequent.

Yet, such is the inconsistency of Human Nature, that while the intelligent American or European, knowing the immense risks, would shrink from sending his family by such a hazardous route, he is himself always ready to "take the chances," for the excitement of participating in one of these great ocean races.

It becomes, then, necessary for the companies to save us from ourselves. This they can only do by absolutely eschewing the dangerous routes. The race would be just as exciting, and fully as conclusive, if made over a less dangerous course. Indeed, instead of being a proof of the speed and excellence of the two vessels, it becomes in a great degree a question of the amount of nerve possessed by the two commanding officers.

I cite as a case in point the recent great race between the White Star steamer *Teutonic* and the Inman steamer *City of New York*, in which the former was victorious, making the passage from Queenstown to Sandy Hook Light-ship in 5 days, 19 hours and 5 minutes, thus lowering the existing record of "best time" by 13 minutes.

The distance traversed by the *Teutonic* was 2,806 knots, at an average speed of 20.1 knots (about 24 miles) per hour, for 139 hours. The *Teutonic* sailed from Queenstown on August 8; at 2.15 A.M. was abreast Roche's Point, and closely followed by the *City of New York*. The daily runs of the *Teutonic* were as follows:

1st day of 24 hours	.....	473	knots.
2d	" "	496	"
3d	" "	512	"
4th	" "	500	"
5th	" "	485	"
6th day to finish	.....	340	"
Total	.....	2,806	knots.

In order for the *Teutonic* to have made this short route, she must have steamed directly across the Banks of Newfoundland, which, according to the above list of runs, she traversed at the rate of 500 knots per day, or 25 land miles per hour.

With regard to the danger that might be caused to the fishing fleet, owing to the establishment of regular lanes at that season, at which the said lanes ran through their fishing grounds, I can do no better than to quote again from Lieutenant Hayden on this subject:

When we consider, however, the enormous importance of transatlantic steam navigation, the demand for great speed and quick passages, the fact that the shortest route is close to Cape Race, that storms, fogs and ocean-currents enter as a factor less and less every year, that a single great ocean steamship, carrying the transatlantic mail, and straining every nerve to lessen the gap that separates the Old World from the New, represents almost, if not quite, as great a value in number of

lives and amount of property as the entire fishing fleet of every nationality, I must say it seems to me that all other interests are necessarily subordinate, and any regulations likely to be effective must be framed accordingly.

The best way to insure any such reform in the present practical century is to show that it will pay; and the most convincing argument that could be brought to bear upon those vessel owners who would persist in following the ice-laden path, would be the loss of freights and passengers, or higher rates of insurance by this route during the dangerous season of the year.

If it were more generally understood by travelers, shippers and underwriters, that in patronizing those vessels which, in defiance of all that experience and common sense suggests, still continued to go over the most unreliable course, then the loss of steady passenger traffic and the increased rate of insurance would probably have the effect of turning into the recognized safe routes all of the obstreperous vessels.

UNITED STATES NAVAL PROGRESS.

THE trial trip of the new cruiser *San Francisco* took place in the Santa Barbara Channel, off the coast of California, August 27, a run of four consecutive hours being made. The preliminary report stated that the ship made the first run of 40 miles in 2 hours, 1 minute, 13 seconds, making an average speed of 19.8 knots per hour. After turning she then ran over the course again, making the 40 miles in 2 hours, 4 minutes, 44 seconds. The time for the whole run was thus 4 hours, 5 minutes, 57 seconds, giving an average speed of 19.57 knots per hour. During a portion of the time the speed ran up to 20.06 knots. It is understood that the correct speed, after making all proper adoptions, will be about 19.70 knots per hour, in which case the *San Francisco* will earn a considerable premium for her builders, as the contract speed was 19 knots, with a premium of $50,000 for each additional quarter knot.

This result makes the *San Francisco* at least the equal of the *Baltimore* and the *Philadelphia*, built in the East.

The *San Francisco* has already been described and illustrated in previous numbers of the JOURNAL. She was designed in the Navy Department, and built at the Union Iron Works, San Francisco. The general dimensions of the ship are: Length, 310 ft.; breadth, 49 ft.; mean draft, 18 ft. 9 in.; displacement, 4,083 tons. She is unarmored, with the exception of a protective deck. The engines were designed in the Bureau of Steam Engineering. There are two direct-acting, vertical, triple-expansion engines, one to each screw, the cylinders being 42 in., 60 in. and 94 in. in diameter and 42 in. stroke, the working pressure being 135 lbs. There are four double-ended boilers 14 ft. 6 in. in diameter and 19 ft. 2 in. long.

The ship will carry twelve 6-in. breech-loading rifles, with a strong secondary battery of rapid-fire and machine guns, and several torpedo tubes.

The *San Francisco* is of the same general type as the *Philadelphia* and *Baltimore*, and, like those ships, promises to be a very handsome and effective cruiser.

THE NORFOLK NAVY YARD.

The Norfolk Navy Yard, under the wise policy pursued by the Navy Department, has been of late years made one of the two great building yards on the Atlantic Coast, being second in importance only to the New York Yard. Norfolk has always been noted for the excellence of its work, and the yard is supplied with an excellent plant both in the plate and the machine shops, though some additions are still needed. The work now in progress makes an excellent showing and the yard is an exceedingly busy place.

Besides a number of vessels under repair, two of the ships of the new Navy are under construction. One of these is Cruiser No. 8, one of the two 3,000-ton cruisers, the other one being at the New York Yard. This ship has made fair progress and begins to show her fine lines already, as the framing and plates go into place. These ships were recently described in the JOURNAL.

The other ship is the *Texas*, the first battle-ship of the Navy. While not so far advanced as the *Maine*—chiefly on account of delay in delivering the steel—this ship has made excellent progress. The framing for the armored deck is in place, most of the lower plating on, and the hull is rapidly assuming shape.

The *Texas* is 290 ft. long, 64 ft. in breadth, 39 ft. 8 in. moulded depth, 22 ft. 6 in. mean draft and 6,300 tons displacement. The hull is built on the cellular double-bottom system. She will have a belt of steel armor extending from 2 ft. above the water line to 4 ft. 6 in. below, while the engines, boilers and magazines will be protected by 12-in. steel-faced armor extending along the sides for 100 ft. and closed at each end by transverse bulkheads 6 in. thick. This armor has 6-in. hardwood backing. The protective deck, 3 in. thick, slopes forward to the point of the ram, 10 ft. below the water-line and aft far enough to cover the steering gear. The main deck carries a redoubt with 12-in. steel armor, in which are the bases of the two turrets, also of 12-in. steel. The conning-tower is of 12-in. steel, and the connections for the steering gear are protected by steel tubes 3 in. thick, while the ammunition hoists are protected by 6-in. steel.

Each turret will carry a 12-in. breech-loading rifle; these guns will each have a complete broadside range, with an additional range of 40° for the forward and 60° for the after gun. There will be also six 6-in. guns; four of these will be in sponsons on the main deck, two of them training from right forward to 25° abaft the beam, and two from right astern to 25° forward of the beam. Of the other two one is mounted forward and the other aft, each having a train of 120°.

The secondary battery of the *Texas* will include four 6-pdr., six 3-pdr. and two 1-pdr. Hotchkiss guns; four 47-mm. and four 37-mm. revolving cannon and four Gatling guns. She will have two military masts, each carrying two machine guns in the top. She will carry a steam launch and steam cutter, each armed with a 3-pdr. rapid-fire gun, and will also carry two second-class torpedo boats on her upper deck. She will be provided with six torpedo-tubes, one forward, one aft and four in broadside.

The ship will have a full electric light plant. The ordinary provision of ammunition will weigh about 170 tons for the large guns and 72 tons for the secondary battery. The coal bunkers will hold 500 tons, and 450 tons more can be carried in the angle above the protective deck.

The engines of the *Texas* are under construction at the Richmond Locomotive Works, and are referred to on another page.

One of the features of the Norfolk Yard is the new Simpson dry dock. This dock is entirely of timber; briefly described, the floor rests on piles driven down in regular rows, 4 ft. apart longitudinally and 3 ft. transversely. Under the keel-blocks, which bear the weight of the ship, four additional rows of piles are driven. On the piles are laid longitudinal rows of heavy pine timbers crossed by similar transverse timbers. Portland cement is filled in about the heads of the piles and up to the floor, which is of heavy Georgia pine timbers. The sides and end rise at an angle of 45° in steps or altars supported by piles; as the sides are built up they are backed by puddled clay carefully rammed in. All the timber above water is creosoted.

The gate of the dock is an iron caisson, held in place by the pressure of the water and kept tight by heavy rubber packing, extending the whole length of the keel and stern.

This dock is 530 ft. long over all; 500 ft. long inside the caisson; 130 ft. wide on top amidships; 50 ft. wide on the floor; 53 ft. wide at entrance, at the bottom, and 85 ft. at top. The gate-sill is 30½ ft. below the coping and 25½ feet below high water. It will take in the largest ship now under construction for the Navy.

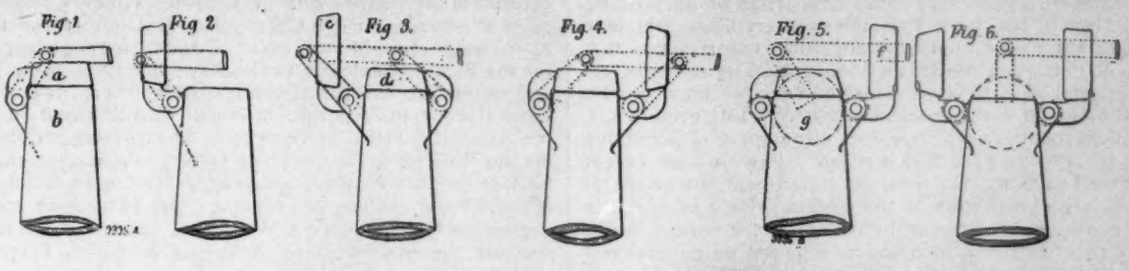
The dock can be flooded by culverts opening directly through the caisson. It holds about 7,000,000 gallons of water, and can be emptied in 90 minutes by two centrifugal pumps each driven by a vertical engine with 28-in. × 24-in. cylinder.

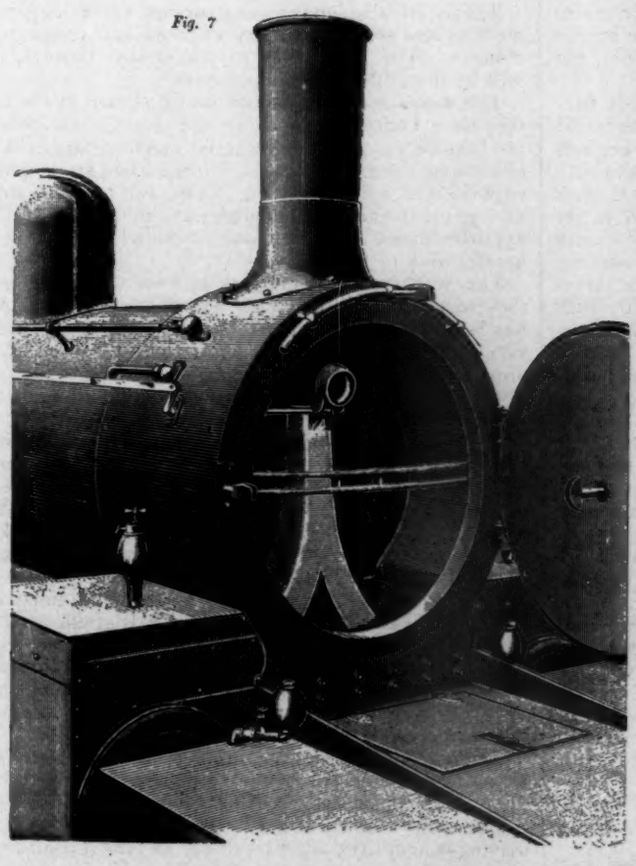
It may be noted here that this dock cost $500,000, while the stone dock at the New York Yard, only 350 ft. in length, cost $2,241,000 to build, besides a large sum yearly for repairs. The first dock on the Simpson plan was built at East Boston in 1853, and is still in excellent condition.

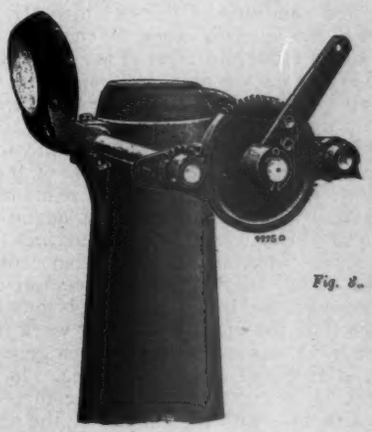
A NEW VARIABLE BLAST NOZZLE.

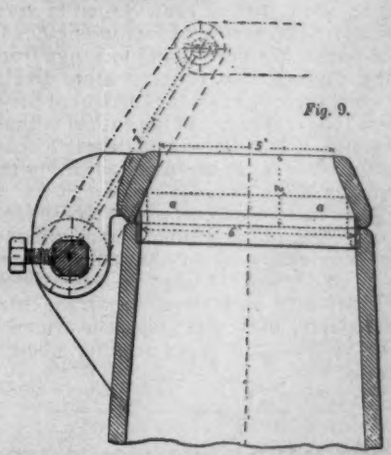
THE accompanying illustrations—from *Engineering*—show a variable blast nozzle, invented and introduced in England by Messrs. Charles Adams, of London, and George Macallan, Manager of the Great Eastern Railway shops at Stratford. It is claimed that this nozzle is free from many of the defects charged against previous devices of the same class.

In the illustration figs. 1–6 show three different forms of this device; figs. 7 and 8 are perspective views of two different patterns, while fig. 9 shows the arrangement for modifying the size of the maximum opening.









VARIABLE BLAST NOZZLE.

It is evident that, so long as a nozzle of invariable aperture is used, the dimensions of this nozzle must be fixed by a consideration of the hardest work which the engine has to perform, and whenever there is a less demand upon the steaming powers of the boiler the draft through the fire has to be controlled by closing the ashpan damper, by admitting an excess of air through the fire-box, or by a combination of these two means. In the device we now illustrate the standard aperture of blast nozzle is retained, but instead of this nozzle being fixed to the blast pipe, it is made in the form of a hinged cap, which can be readily lifted off, leaving a larger opening. Thus, in figs. 1 and 2, which show the form of the device which has been hitherto chiefly used, *a* is the cap, which has an orifice of the standard size, while the main part of the blast pipe *b* terminates in an aperture of larger size. In fig. 1 the cap is shown closed down on the top of the blast pipe, being held firmly in position by a clamping screw which grips the rod by which the nozzle is worked, this rod extending to the foot-plate. In fig. 2 the cap is shown raised, thus leaving the larger orifice available for the discharge of the steam. As will be seen from fig. 7, the cap when thus raised is very accessible for cleaning.

In figs. 3 and 4 is shown a modified arrangement in which two caps *c d* of different diameters are provided, either cap being placed on the top of the blast pipe at pleasure. This arrangement has the advantage that, by making the caps of different depths each diameter of nozzle can be made to stand when in use at that height in the smoke-box which gives the best results, the height at which a blast nozzle is placed having, as is well known, a material effect on the draft produced. Another modification, of a similar character to that last mentioned, is shown by figs. 5 and 6, and in perspective by fig. 8, the two caps, *f g*, being in this case operated by a pair of partial pinions which gear intermittently into an intermediate wheel as shown, this wheel having teeth on part of its circumference only. In fig. 8 this gear is shown close to the blast pipe, it having been mounted thus for convenience in photographing; in reality, however, it is placed outside the smoke-box.

Fig. 9 is a section of the upper end of the blast pipe, fitted with Mr. Macallan's blast nozzle, and shows the provision made for varying the maximum area, the end of the fixed blast pipe having inserted in it a bush, the bore of which can be readily modified. Thus the dotted lines *a a* show a bush with a smaller aperture than that represented in full lines. Thus, for a particular engine, the maximum area of discharge permitted when the cap is lifted can be readily adjusted to suit the requirements of the case.

We have said that the normal area of a locomotive blast pipe is fixed by a consideration of the heaviest work to be done; but it will be readily understood that the occasion in which such maximum demands are made upon an engine constitute but a very small proportion of its working life. Had it not been that the ordinary blast pipe is to some extent an automatically adjusting contrivance—that is, to say, that when less steam is being used its action is less violent, and *vice versa*—the use of variable blast nozzles would long ago have become a necessity. But, even as it is, this adjustment is very imperfect, although its imperfection is far from being generally realized. Few, indeed, except those who have actually tried the experiment, are aware for what a large proportion of the working day a blast nozzle very considerably greater in area than the normal size is amply sufficient for a locomotive engaged on general service. It is this condition of things which Mr. Macallan's blast nozzle is intended to meet, by enabling a driver to work with a very moderate blast at all times when such a blast will suffice, thus not only avoiding waste of fuel, but also reducing the back pressure in the cylinders.

Up to the present time 60 locomotives on railroads running out of London have been fitted with the arrangement of blast pipe above described, and some of these engines have now been working upward of twelve months and with highly satisfactory results. The blast nozzle area, with the movable cap lifted, varies in these engines from 30 per cent. to, in some cases, as much as 77 per cent. in excess of the normal area. In the case of locomotives working main line passenger and freight trains, it is found that three-fourths of the time the engines do their work readily with the cap raised, the nozzle area being then generally about 30 per cent. in excess of the normal area. In the case of engines working heavy suburban traffic three-fourths of the work is also done with the cap raised, the nozzle in this case averaging about 40 per cent. larger in area than the ordinary orifice. The saving of fuel in engines fitted with this variable nozzle has been found to range from 10 to 15 per cent., the engines also running more freely with the cap raised, while there is less wear and tear of fire-boxes and tubes and less tube leakage. In the case of engines worked at different times, with different qualities of coal also, the arrangement gives a ready means of adjusting the draft to the requirements of the fuel.

The nozzle we have been describing has so far only been used on locomotives, but it is equally applicable to portable and traction engines, and on the latter class of engines especially, it would, we consider, be exceedingly useful. Our illustrations also only show the arrangement as applied to an ordinary blast pipe, but it is evidently equally applicable to vortex blast pipes or other modifications of the usual form.

THE RICHMOND LOCOMOTIVE WORKS.

THE Richmond Locomotive works in Richmond, Va., had their origin in a shop engaged in building portable and stationary engines, saw-mills and similar work, to which was added later the construction of small locomotives for logging railroads. Some time ago the company was reorganized and shops were built on the outskirts of Richmond which in size, equipment and character of the work turned out will stand comparison with any of the older locomotive shops.

The buildings include a large foundry, smith shop, boiler shop, machine shops, erecting shop, wood-working shop, paint shop and the usual smaller buildings, such as pattern room, storehouse, etc. The erecting shop is 143 × 300 ft. in size, and is provided with an overhead traveling crane which is capable of lifting the largest locomotive and moving it to any part of the building. A transfer table with the necessary tracks connects the different shops and provides for the easy handling of work.

The plant includes many fine tools of large size, such as hydraulic riveters and flanging machines; frame planers; wheel-lathes, etc., and a number of tools specially designed for locomotive work.

The character of the work done can best be shown by a brief statement of the work now in progress and recently turned out, which includes 15 consolidation engines with 20 × 24-in. cylinders, for the Richmond & Danville; 2 consolidation engines with 21 × 24-in. cylinders and Belpaire fire-boxes, for the Chesapeake & Ohio; three 19 × 24-in. mogul freight and two 17 × 24-in. passenger engines for the Florida Central & Peninsular; one 17 × 24-in. passenger engine for the Greenfield & Northern, two of the same size for the Atlantic & North Carolina and one for the Atlantic & Danville; one 18 × 24-in. passenger engine for the Raleigh & Gaston; one 18 × 26-in. mogul engine for fast freight or heavy passenger service on the Richmond, Fredericksburg & Potomac; one 14 × 20-in. mogul engine for the Aberdeen & West End, and one of the same size for the Southwestern Arkansas & Indian Territory Railroad.

There are also under construction some logging locomotives and some stationary engines and creosoting machinery. The chief work of the shops, however, is and will be the building of locomotives.

The capacity of these shops is also shown by the fact that they have contracted to build the engines and boilers of the battle-ship *Texas*, now under construction at the Norfolk Navy Yard. This work includes two triple-expansion engines with cylinders 36 in., 51 in. and 78 in. in diameter and 39 in. stroke, with condensers, pumps and all other appurtenances, and four double-ended boilers 14 ft. diameter and 17 ft. long.

The work on these engines is now well advanced and they will be ready probably before the ship is. All of it has been done in the shops, the large cylinders being cast successfully in the foundry. Several of these cylinders are now being bored and turned in the machine shop, and a large part of the smaller work on the valves and condensers is completed.

The flanging and bending of the 1¼-in. plate for the boilers is a very interesting operation, and has been very successfully done. The boilers are beginning to assume their shape, and the work is making rapid progress. The fact that the work on these large boilers has been quickly and well done, and that the other work for the *Texas* has been handled without difficulty, shows the capacity of the shops.

The accompanying illustration shows a fine consolidation locomotive built for the Richmond & Danville Railroad—one of an order of 15. This engine has cylinders 20 in. in diameter with 24 in. stroke, and 50-in. driving-wheels. The driving-wheel base is 14 ft. and the total wheel base 21 ft. 6 in. The weight is 118,000 lbs., of which 104,000 lbs. are on the drivers.

The boiler, of steel ¼ in. thick, is 60 in. diameter of barrel; the fire-box is 102¾ × 41⅞ in. inside. The tubes are 2¼ in. diameter and 12 ft. 10½ in. long.

The main frames are 4 in. wide and 3½ in. deep. The driving-wheel tires are 3 in. thick, and the second and third pair are plain, without flanges. The driving axles are of steel, the journals being 7½ in. diameter and 8½ in. long. The driving-box brasses are of phosphor-bronze. The side-rods are of steel, with solid ends, provided with phosphor-bronze bushes.

The two-wheel truck has 30-in. steel-tired wheels; the truck axle has journals 5⅛ in. diameter and 10 in. long.

The cylinders, as already noted, are 20 × 24 in. They are provided with the Richardson-Allen balanced valves; the valve motion is of the ordinary shifting link type.

Space prevents the publication of the specifications in full. These engines are excellent examples of the latest practice, and ought to do good service.

The tender tank holds 3,300 gals. The tender has brakes on both trucks, and the engine is also provided with driver-brakes.

CONSOLIDATION LOCOMOTIVE FOR THE RICHMOND & DANVILLE RAILROAD.

BUILT BY THE RICHMOND LOCOMOTIVE WORKS, RICHMOND, VA.

THE ESSENTIALS OF MECHANICAL DRAWING.

By M. N. Forney.

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(*Continued from page 422.*)

CHAPTER VI.

SCREW THREADS.

No description of an ordinary screw and nut is needed, excepting to point out that the threads of screws are of different forms and proportions, and that nearly all those which are commonly used have what are called "*right-handed*" *threads*, that is, the threads wind around the bolt, so that when looking at the end of a bolt the nut must be turned in the same direction that the hands of clocks or watches turn, to screw it on, and it must be turned the reverse way to unscrew it. The thread of what are called *left-handed screws* wind around the bolts in the reverse direction to those which are right-handed, and consequently the nuts must be turned in an opposite direction in screwing them on and off their bolts. For the present only right-handed screws will be considered.

In the construction and use of machinery and other metal structures it is of the utmost importance that all screws and nuts which are of a given nominal diameter should be *interchangeable*—that is, that any screw of, say, ¾ in. outside diameter, should fit any nut which is supposed to be of the same internal diameter. To do this their diameters must be *exactly* alike, the form of the threads must be the same, and the distance the threads advance in winding around the bolt or their *pitch* must be the same. It should be mentioned here, perhaps, that all screws commonly used are what are called *single threaded*, that is, they each have a single thread instead of two or more. If we take a string and wind it around a pencil in the form of a spiral, it will represent a single-threaded screw, and if we wound two or three threads alongside of each other, they would represent double or treble-threaded screws. These latter kinds are so seldom used that they will not be considered further.

Until a few years ago the most common form of the threads of screws was what is known as the V thread, represented in fig. 161. This was made sharp at the top and bottom, with sides which stood on an angle of about 60° with each other, as indicated in the figure referred to. The pitch of the threads, or, as it is commonly expressed, the number of threads to an inch, of bolts of the same diameter, formerly varied a good deal in different places and in screws made in various shops. In 1864 the inconvenience and confusion from this cause became so great that it attracted the attention of the Franklin Institute of Philadelphia, and a committee was appointed by that association to investigate and report on the subject. That committee recommended the adoption of the Sellers system of screw-threads and bolts, which was devised by Mr. William Sellers, of Philadelphia. This same system was subsequently adopted as the standard by both the Army and Navy Departments of the United States, and then by the Master Mechanics' and Master Car Builders' Associations, so that it may now be regarded, and in fact is often called the United States standard, but the design is due to Mr. Sellers, and the system should be designated by his name.*

Before describing the Sellers system of screw threads an explanation will be given of the method of drawing an old-fashioned V thread represented in fig. 161. A bolt 2 in. in diameter has been selected so that the drawing will not be too minute for the learner's hands and eyes. The number of threads is 4½ to an inch, or a pitch of ⅔ in., and the angle between the sides of the threads 60°, as shown between 4′ and 5′. To draw such a screw, lay down the usual center line and the outline *a b c d* of the bolt or bar. In order to have an even number of divisions lay off a distance *b q*=2 in. Then with spring dividers subdivide this space into nine equal parts. With the 30° side of a triangle draw from the points of subdivision the lines *b e* 1*e*, 1*e*′, 2*e*′, 2*e*″, etc., which will represent the outline of the thread on one side of the bolt. In winding completely around the bolt the thread 1 advances lengthwise from 1 to 2. In a half revolution, or from 1 to 1′, it advances half that distance. Consequently the point of the thread at 1′ should be opposite its root at *e*′. If lines are drawn from the roots *e*, *e*′, *e*″, *e*‴, etc., of the thread and perpendicular to the center line of the screw or bolt and intersecting *c d*, as shown at 1′, 2′ and 3′, the intersections will be the positions of the points of the thread on that side of the screw and the sides of the thread can be drawn from those points, as explained.

The lines 1 1′, 2 2′, etc., which show the points of the thread as it passes from one side of the bolt to the other, would, if correctly represented, be curves. As already explained, it is a somewhat difficult problem to draw them correctly. The method of doing this will be explained farther on. For nearly all practical purposes, however, the point of the thread may be shown by straight lines, as in the figure under consideration. These lines should be drawn from the points 1, 2, 3, etc., on one side of the bolt, to 1′, 2′, 3′, etc., on the opposite side. In doing this care must be taken to get the direction of their inclination right, because if they are inclined in the opposite way from that shown in the engraving it would represent a left-hand screw. The lines 1 1′, 2 2′, 3 3′, etc., drawn from the points on one side of the bolt to those on the other will thus represent a *projection*, as it is called, of the point of the thread. Other lines *e f*, *e*′ *f*′, *e*″, *f*″, etc., drawn to connect the roots of the thread on opposite sides, will complete the representation of the screw. It will be noticed that the lines which show the points and those which show the roots are not exactly parallel to each other.

It was found that when V-shaped threads of the form shown in fig. 161 were used that their sharp edges were liable to injury, while at the same time the sharp points of the thread added very little strength to it. For this reason, when Mr. Sellers designed the standard thread which bears his name, he made the outer edge and also the root of the thread flat, as shown in fig. 162, and also in fig. 164. The latter engraving represents a section of the Sellers thread, which, for the sake of clearness, is drawn to a scale four times that of fig. 162, or four times the actual size.

The angle between the sides of the Sellers standard thread was fixed at 60°. To lay out such a thread, lay off the pitch *a b*, fig. 164, on a line *o o*′, and from *a* and *b* draw lines *a f*, *a f*′, *b f*′ and *b f*″ at angles of 60° to each other. These will form the outline of a V thread. Then subdivide one of the sides, as *a f*′ into eight equal parts, and draw lines 1 1′, 2 2′, 3 3′, etc., through the points of subdivision and parallel to *o o*′. Take off the parts *e*. *e*′ included between the parallel lines o o′ and 1 1′ from the point of the thread and fill in the parts *c*, *c*′, *c*″, included between the lines 7 7′, and 8 8′, at the bottom or root of the thread, as indicated by the shading. Then the width of the flat top and bottom measured parallel with the axis or center line of the screw will be equal to one-eighth of the pitch, and the diameter *d* of the bolt measured at the root of the thread can be calculated by dividing 1,299 by the number of threads to an inch and deducting the quotient from *D*, the outside diameter of the screw. It will be seen that the strength of the bolt is materially increased by filling in at the root of the thread.

The proportions of the Sellers system of screw threads for bolts of different diameters, and also the proportions of bolt-heads and nuts, of the same system, are given in the accompanying table.

To draw a Sellers thread we will take a bolt 2 in. in diameter, fig. 162. The pitch of the threads is again laid off on a line *a b* as before. Then from the table take the width of the flat portion of the thread, and set this off from the points of subdivision on *a b*, either above or below them. Then from the points thus laid down draw the sides of the thread, as in fig. 161. Complete the V shape of the point of one of the threads. With spring dividers measure the distance of the point of intersection of the two sides of the thread from *a b*, and lay off this same dimension at *e*″, the root of the thread, and draw *g h*, which will form the bottom of the spaces between the threads. Draw the outlines of the threads on the line *d c* opposite the spaces on *a b*, as in fig. 161. The diagonal lines 1 1′, 2 2′, 3 3′, etc., which represent the outer edges of the thread, may then be drawn, and also *e f*, *e*′ *f*′, *e*″ *f*″, etc., which represent the roots of the thread. Each pair of the lines which represent the outer corners, and those which show the root, will be parallel to each other, but as in fig. 161, the lines at the root and those at the point will not be exactly parallel, as the learner will observe if he lays down all the dimensions of the thread precisely.*

In doing this he will have found out how very difficult it is to draw a thread of this kind with sufficient precision, so that it will not appear more or less distorted, and if he should attempt to do it on a reduced scale, or to draw a smaller sized bolt, he will find that the difficulty increases with the reduction in the scale and size of the bolt. For this reason an easier method is usually employed in practice, which saves much time, labor and pains, and for most practical purposes answers as well as that which has been described. A bolt is drawn as in fig. 165.

* "Catechism of the Locomotive," by M. N. Forney.

* The fine lines *a b*, *g h*, and *d c*, in figs. 161 and 162 and at 1′, 2′, 3′ in fig. 161, are intended to represent pencil lines, and should be rubbed out after the drawing is completed.

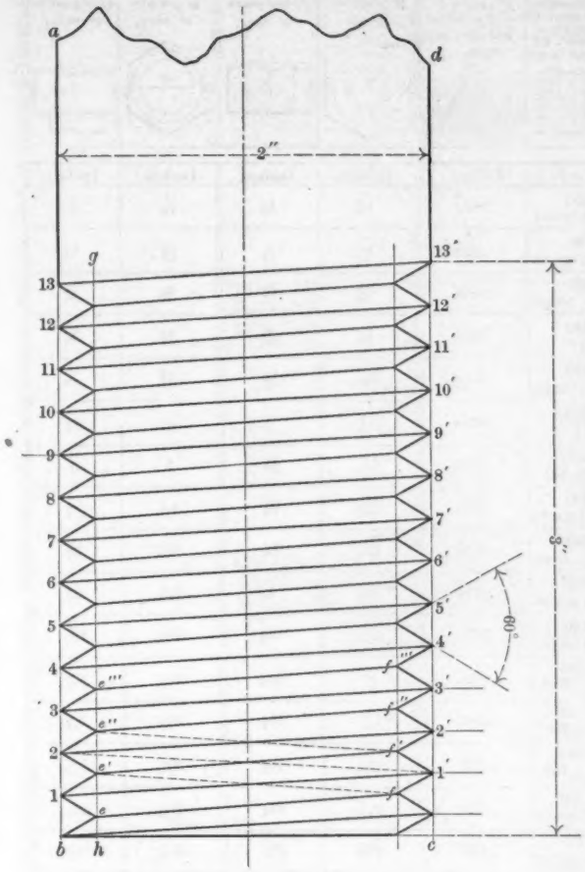


Fig. 161.

2-INCH SCREW: FULL SIZE.

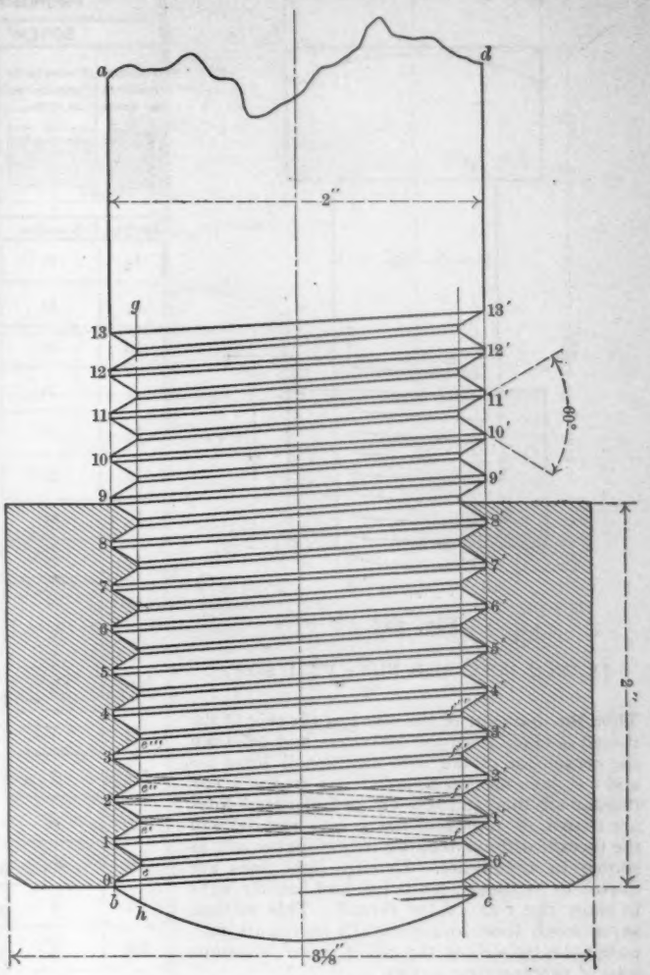


Fig. 162.

2-INCH SCREW AND NUT: FULL SIZE.

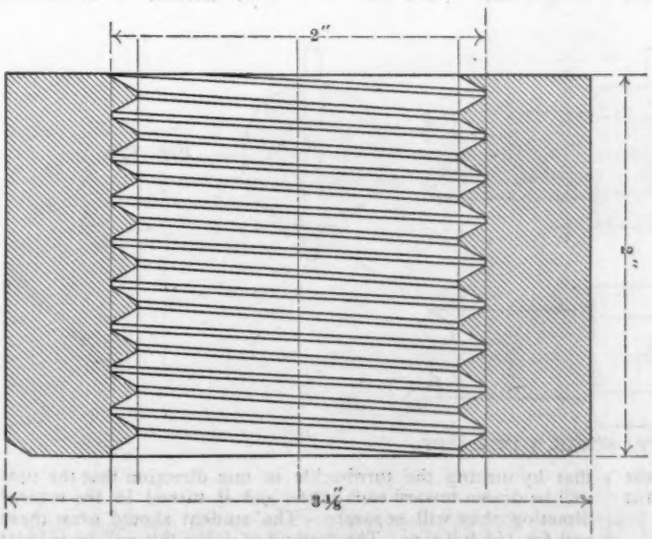


Fig. 163.

SECTION OF 2-INCH NUT: FULL SIZE.

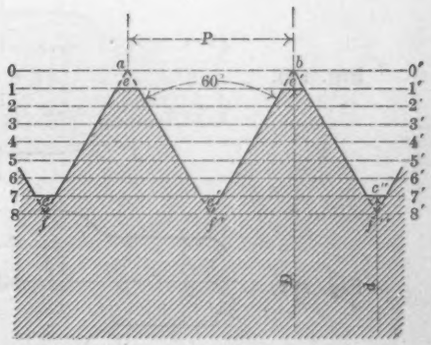


Fig. 164.

SECTION OF SCREW-THREAD: FOUR TIMES FULL SIZE.

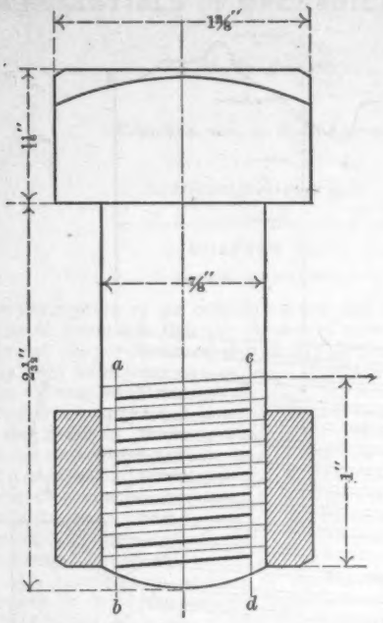


Fig. 165.

1⅜-INCH BOLT AND NUT: FULL SIZE.

PROPORTIONS FOR SELLER'S U.S. OR FRANKLIN INSTITUTE STANDARD.

SCREW THREADS.				NUTS.		BOLT HEADS.	
D=OUTSIDE DIAMETER OF SCREW.	N=NUMBER OF THREADS TO AN INCH.	d=DIAMETER AT ROOT OF THREAD = DIAM. OF HOLE IN NUT	f = WIDTH OF FLAT AT POINT AND ROOT OF THREAD.	W = WIDTH OF NUT.	T=THICKNESS OF NUT.	w = WIDTH OF HEAD.	t = THICKNESS OF HEAD.

Inches.	Number.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
¼	20	.185 $\frac{3}{16}$ scant	.0062	½	¼	$\frac{7}{16}$	$\frac{5}{16}$
$\frac{5}{16}$	18	.240 ¼ scant	.0074	$\frac{15}{32}$	$\frac{5}{16}$	$\frac{17}{32}$	¼
⅜	16	.294 $\frac{19}{64}$ scant	.0078	$\frac{11}{16}$	⅜	⅝	$\frac{5}{16}$
$\frac{7}{16}$	14	.344 $\frac{11}{32}$	.0089	$\frac{15}{32}$	$\frac{7}{16}$	$\frac{23}{32}$	⅜
½	13	.400 $\frac{13}{32}$ scant	.0096	⅞	½	$\frac{13}{16}$	$\frac{7}{16}$
$\frac{9}{16}$	12	.454 $\frac{29}{64}$	.0104	$\frac{31}{32}$	$\frac{9}{16}$	$\frac{29}{32}$	½
⅝	11	.507 ½ full	.0113	$1\frac{1}{16}$	⅝	1	$\frac{9}{16}$
¾	10	.620 ⅝ scant	.0125	1¼	¾	$1\frac{3}{16}$	$\frac{11}{16}$
⅞	9	.731 $\frac{47}{64}$ scant	.0138	$1\frac{7}{16}$	⅞	1⅜	$\frac{13}{16}$
1	8	.837 $\frac{27}{32}$ scant	.0156	1⅝	1	$1\frac{9}{16}$	$\frac{15}{16}$
1⅛	7	.940 $\frac{15}{16}$ full	.0178	$1\frac{13}{16}$	1⅛	1¾	$1\frac{1}{16}$
1¼	7	1.065 $1\frac{1}{16}$ full	.0178	2	1¼	$1\frac{13}{16}$	$1\frac{3}{16}$
1⅜	6	1.160 $1\frac{5}{32}$ full	.0208	$2\frac{3}{16}$	1⅜	2⅛	$1\frac{5}{16}$
1½	6	1.284 $1\frac{3}{32}$ full	.0208	2⅜	1½	$2\frac{5}{16}$	$1\frac{7}{16}$
1⅝	5½	1.389 $1\frac{25}{64}$ scant	.0227	$2\frac{5}{16}$	1⅝	2½	$1\frac{9}{16}$
1¾	5	1.491 1½ scant	.0250	2¾	1¾	$2\frac{11}{16}$	$1\frac{11}{16}$
1⅞	5	1.616 1⅝ scant	.0250	$2\frac{13}{16}$	1⅞	2⅞	$1\frac{13}{16}$
2	4½	1.712 $1\frac{23}{32}$ scant	.0277	3⅛	2	$3\frac{1}{16}$	$1\frac{15}{16}$
2⅛	4½	1.837 $1\frac{27}{32}$ scant	.0277	$3\frac{5}{16}$	2⅛	3¼	$2\frac{1}{16}$
2¼	4½	1.962 $1\frac{31}{32}$ scant	.0277	3½	2¼	$3\frac{7}{16}$	$2\frac{3}{16}$

Then the diameter of the screw at the root of the thread is taken from the table and laid off from the center line of the bolt and pencil lines *a b* and *c d*, defining that diameter, are drawn. The threads are then stepped off and diagonal lines are drawn to represent the points and roots of the thread, without drawing its outlines at all, as shown in the figure. Usually light lines are drawn to represent the point, and heavier ones to show the root of the thread. This method saves much time, and generally serves its purpose quite as well as the other, more laborious way of representing screws.

In drawing a screw and nut, the outside of the screw is usually shown, and, as in figs. 162 and 165, the nut is shown in section.

Fig. 163 represents a section of a nut without the screw. The only peculiarity about it is the inclination of the lines which represent the threads. These, it will be seen, are inclined in the reverse direction to those in fig. 162. The reason for this will be apparent if we follow the thread in fig. 162 from 1 to 1′, and then notice that the dotted lines, which represent the thread on the opposite side of the screw, are inclined the reverse way to the full lines 1 1′. The dotted lines in fig. 162 are shown by full lines in fig. 163.

TURNBUCKLE AND SWIVEL.

Figs. 166 and 167 are two views of an ordinary turnbuckle, and show the use of right and left-hand thread screws. As shown by the way the threads are drawn, the screw on the rod *A* is right-handed, and that on *B* is left-handed. It is obvious that by turning the turnbuckle in one direction that the rods will be drawn toward each other, and if turned in the reverse direction they will separate. The student should draw these and fig. 168 full size. The method of doing this will be evident from the engraving without other explanation.

Fig. 168 represents a section, what is called a *swivel*, which is used for the same purpose as a turnbuckle. Instead of being

Fig. 169.

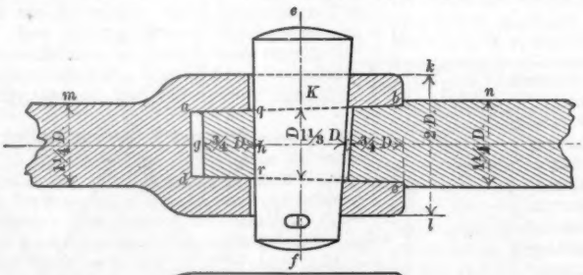


Fig. 170.

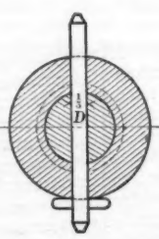
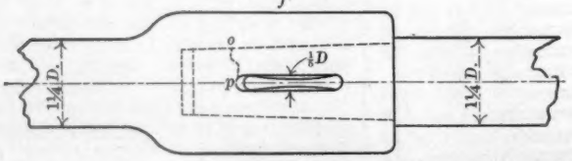


Fig. 171.



COTTER JOINT: SCALE, 3 IN. = 1 FT.

TURNBUCKLE · SCALE, ½ IN. = 1 IN.

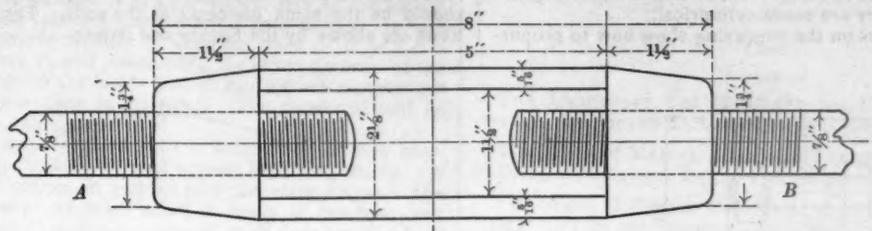


Fig. 166.

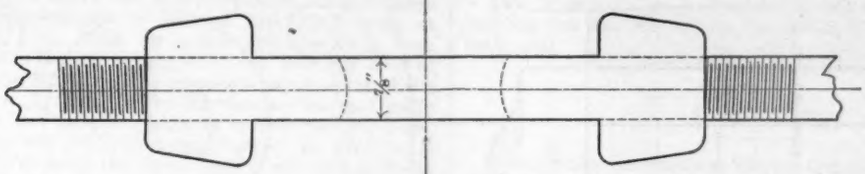


Fig. 167.

Scale ½″=1 In.

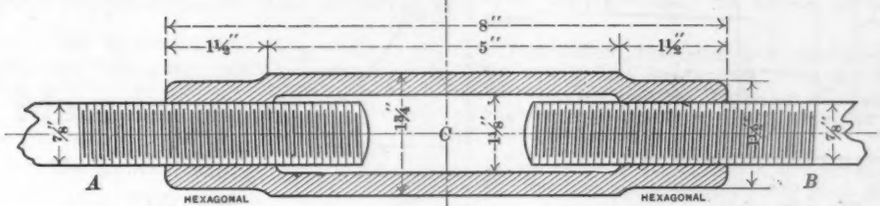


Fig. 168.

SWIVEL

SWIVEL: SCALE, ½" IN. = 1 IN.

Fig. 172.

Fig. 174.

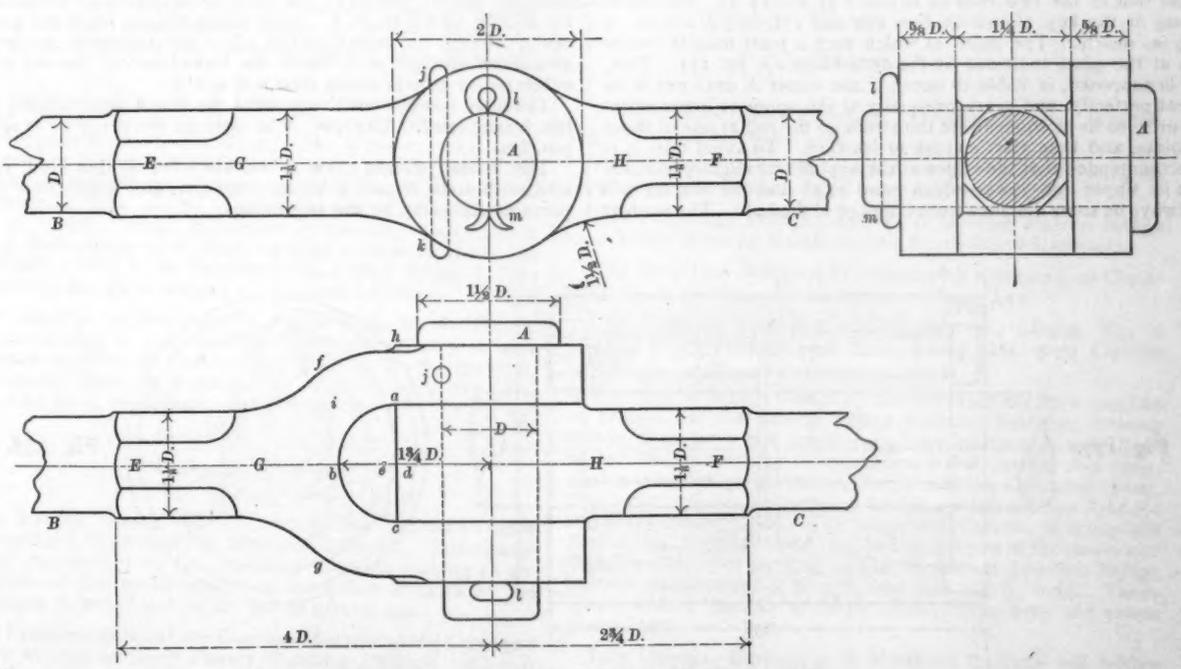


Fig. 173.

KNUCKLE JOINT: SCALE, ¼ IN. = 1 IN.

made open like the turnbuckle, the part *C*, which forms the nuts of the swivel, and which is shown in section in the engraving, is tubular. The ends are made hexagonal, so that it can be held with a wrench to turn it. The rod *A* has a right-hand, and *B* a left-hand thread, the same as the turnbuckle.

COTTER OR KEYED JOINT.

Figs. 169 is a longitudinal, and fig. 170 a transverse, section on the line *e f*, and fig. 171 a plan of a cotter joint, which is used for connecting two parts of a rod, as a valve-stem, pump-

rod, etc. In making such joints they are sometimes made tapered or conical in the socket *a b c d*, as shown in the engraving, and sometimes they are made cylindrical.

The figures and letters on the engraving show how to proportion such a joint of any dimensions. Thus the diameter *D* on the line *e f* is taken as the unit or standard from which the other parts are proportioned. In the engravings $D=1\frac{1}{2}$ in. The distance *g h* should then be three-fourths of *D*, or $1\frac{1}{8}$ in. The width of the key or cotter *K* at *h i* should be $1\frac{1}{8}$ $D=2$ in. The outside diameter *k l* of the socket is equal to 2 $D=3$ in., and that of the two rods at *m* and *n* $1\frac{1}{4}$ $D=1\frac{7}{8}$ in. The thickness of the key, shown in figs. 170 and 171, is $\frac{1}{8}$ $D=\frac{3}{10}$ in. or $\frac{5}{16}$ in. nearly. The point at which such a joint usually breaks is at the place indicated by the dotted line *o p*, fig. 171. This, it is supposed, is liable to occur if the cotter *K* does not fit its seat perfectly, and bears unequally at the upper or lower edges *q* or *v*, so as to concentrate the strain on the rod at one of those points, and thus start a crack or fracture. To avoid this, it is recommended that the edges of the keyhole be slightly rounded at its upper and lower edges *q* and *v*, so that the bearing will always be some distance from the edge of the hole. The student should design such a joint with a diameter of say $1\frac{3}{4}$ in. at *D* and draw it full size.

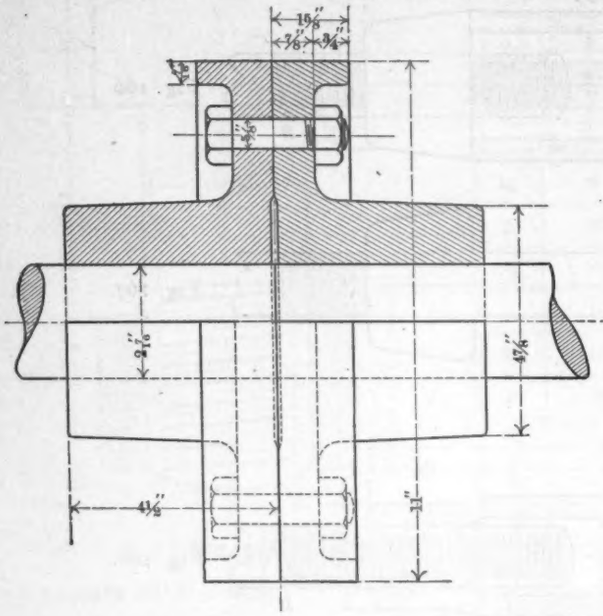


Fig. 175.

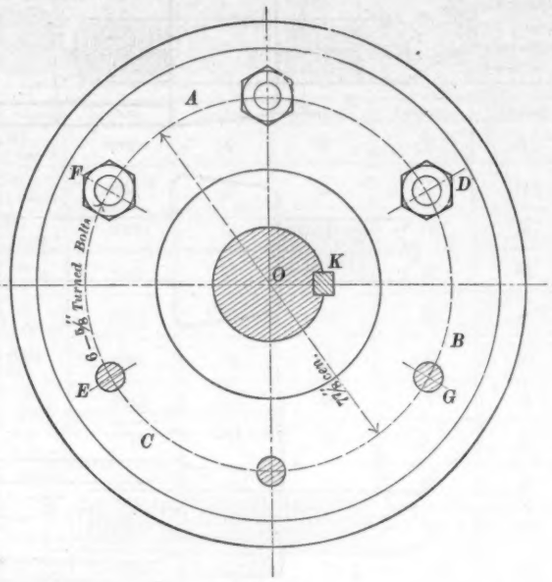


Fig. 176.

PLATE COUPLING: SCALE, 3 IN. = 1 FOOT.

KNUCKLE JOINT.

Figs. 172, 173 and 174* represent three views of a flexible joint. The figures and letters on these are also intended as a guide in proportioning joints of this kind, the diameter *D* of the rods *B* and *C* being taken as the unit or standard. The pin *A* should be the same diameter as the rods. The other proportions are shown by the figures and letters.

When a round rod, as *B* and *C*, joins another part which is square or rectangular, as *G* or *H*, the transition of form from one to the other is apt to appear awkward. For this reason it is customary to make a portion, as *E* and *F*, between the round and rectangular parts octagonal. Such a "*finish*," as it is called, is shown in the engravings, the drawing of which presents no special difficulty. In drawing the curve *a b c* the center should be taken at *d*. In drawing the curves *f* and *g* the center should be moved to the left a short distance, so as to give more strength at *i*, where the forked end of the rod *B* is subjected to greater strain than it is at *a h*.

The pin *j k* is intended to prevent the pin *A* from turning in the forked end. The pin *A* is held in its place by a split pin, *l m*.

The learner should draw a knuckle joint of this kind, full size, with rods *B* and *C* $1\frac{3}{4}$ in. diameter, and proportion the parts as indicated by the engravings.

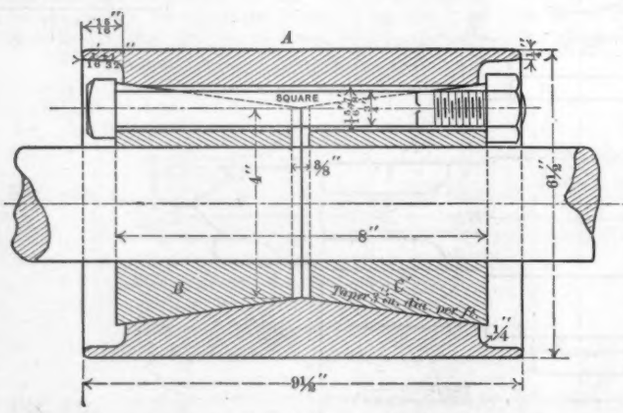


Fig. 177.

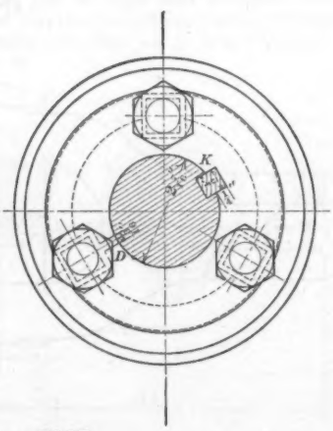


Fig. 178.

DOUBLE-CONE COUPLING: SCALE, 3 IN. = 1 FOOT.

SHAFT COUPLING.*

Figs. 175 and 176 represent what is called a *plate-coupling* for shafting used in transmitting power. In fig. 175 the upper half is shown in section and the lower half is an outside view. The coupling is made in two halves, which are each keyed to the end

* These engravings are taken from Machine Drawing and Design by William Ripper.

* The drawings of this, the double cone coupling and the 30 in. pulley were furnished by the Robert Poole & Son Company, of Baltimore.

of a shaft by keys, one of which is shown at *K*, and are bolted together with six bolts, as shown. In laying off the bolts, as shown in fig. 176, a circle, *A B C*, is drawn, and its circumference is subdivided into six parts with its own radius. It may also be conveniently divided by drawing lines *D E* and *F G* through the center *O*, and intersecting the circumference of the circle. The bolts in the lower half of fig. 176 are represented in section to save time in drawing. The figures should be drawn in full or half size.

Figs. 177 and 178 represent what is called a *double-cone coupling*, also used for uniting parts of a shaft together. In fig. 177 the coupling is shown in section with the shaft inside. The coupling consists of an outer shell, *A*, made of cast-iron, and two cones, *B* and *C*, which are turned to fit into the inside of the shell *A*, which is bored out to receive them. These cones are cut apart longitudinally or parallel with their axes, as shown at *D*, fig. 178. Both the cones and the shell have grooves in them to receive square bolts, the forms of both of which are shown in fig. 178. The cones are keyed to the shafts as represented at *K*, fig. 178. When the cones are inserted inside of the shell, and are drawn together by screwing up the bolts, their conical form and that of the openings in the shell cause them to contract and grasp the shafts tightly, and also to fit the openings in the shell perfectly. If at any time they should get loose, they can easily be made tight by screwing up the nuts on the bolts. Figs. 177 and 178 should be drawn either half or full size.

(TO BE CONTINUED.)

Manufactures.

Marine Engineering.

THE Iowa Iron Works, Dubuque, Ia., have recently completed the steamboat *Herold* for the line between St. Louis and Memphis. She is 245 ft. long, 34 ft. beam, and has a steel hull, with five water-tight compartments. There are two engines, each 19 in. cylinder and 8 ft. stroke, and four double-flue boilers, 4 ft. diameter and 26 ft. long.

THE Continental Iron Works, Brooklyn, N. Y., report a steadily increasing demand for their corrugated boiler flues. A number of orders have recently been received for vessels building on the Lakes, besides others for the seaboard. All the new naval vessels use these corrugated furnaces in their boilers.

AT the yard of Neafie & Levy, in Philadelphia, the new steamer *City of Seattle*, for the Puget Sound & Alaska Steamship Company is nearly completed. She is 260 ft. long, 40 ft. beam, and 17 ft. depth of hold, and of 1,410 tons register. She has accommodations for 250 passengers. The engines are of the compound type, having cylinders 32 and 60 in. in diameter by 36 in. stroke. Steam is supplied by two steel boilers, each 13 ft. in diameter by 14 ft. long, carrying a pressure of 145 lbs. The propeller is 11 ft. in diameter, with a pitch of 18½ ft. On her trial trip she made a speed of 16½ knots an hour.

THE smallest triple-expansion engine built in the United States, according to the *American Shipbuilder*, has just been completed by Riley & Cowley, Brooklyn, N. Y., for the 50-ft. steam launch *Secret*, of Washington. The cylinders are 4 in., 6½ in., and 10 in. in diameter and 8 in. stroke.

Manufacturing Notes.

THE Sterling Emery Wheel Company has decided to move its works from West Sterling, Mass., to Tiffin, O. The change is made on account of the growth of business making an enlargement of the works necessary, and also because of the advantages to be secured by the use of natural gas.

THE business offices of the Dunham Manufacturing Company are now located at 703-7 Phenix Building, Chicago. All correspondence for the Company should be addressed to that office.

THE Bucyrus Steam Shovel & Dredge Company, Bucyrus, O., has its works very busy on orders, and has turned out this year a large number of dredges and steam shovels.

THE Franklin Steam Boiler Works of McNeil & McLachlin (Greenpoint), Brooklyn, N. Y., are constructing a sheet steel water trough for the New York Central & Hudson River Railroad Company. It will be delivered in 60 ft. sections. The total weight is over 75 tons. This concern has an extensive line of work in its shops destined for Detroit, Mich., and Toronto, Can.

Cars.

THE Harrisburg Car Manufacturing Company is building 400 box cars for the Richmond & Danville Railroad.

THE shops of Murray, Dougall & Company, Milton, Pa., are building 100 box cars for the Long Island Railroad.

THE Wells & French Company, in Chicago, is building 750 freight cars for the Illinois Central Railroad.

THE Missouri Car & Foundry Company, in St. Louis, is building 300 box cars for the Louisville, New Orleans & Texas Railroad.

Locomotives.

THE Brooks Locomotive Works, Dunkirk, N. Y., are building six ten-wheel passenger engines for the Atchison, Topeka & Santa Fé Railroad. They have 19 × 26-in. cylinders and 63-in. driving-wheels; the boilers are 60 in. in diameter of barrel.

THE Buffalo, Rochester & Pittsburgh Railroad has ordered six new freight locomotives from the Baldwin Locomotive Works. The Baldwin Works are building 20 ten-wheel freight engines, with 17 × 24-in. cylinders for the Lake Shore & Michigan Southern.

THE shops of H. K. Porter & Company, in Pittsburgh, are building four mine locomotives to go to Mexico.

THE Rogers Locomotive Works, Paterson, N. J., are building three locomotives for the Monterey & Mexican Gulf; four to go to Cuba; two to go to Jamaica; five for the Chesapeake & Ohio, and 22 for the New York Central & Hudson River Railroad. They are also building two snow-plows for the Jull Manufacturing Company.

THE Schenectady Locomotive Works are building five heavy passenger engines for the Cincinnati, Hamilton & Dayton Railroad.

Bridges.

THE Southern Bridge Company, Birmingham, Ala., is building an iron bridge at Clinton.

THE Missouri Valley Bridge & Iron Works are building an iron bridge near Dallas, Tex., over the Trinity River.

THE Pittsburgh Bridge Company is building an iron bridge over Sandy River in Maine, for the Sandy River Railroad.

THE King Iron Bridge & Manufacturing Company, of Cleveland, O., is building an iron bridge at Paris, Tex.

THE Vermont Construction Company, St. Albans, Vt., is building an iron bridge near Montgomery, Ala., over Catoma Creek.

THE Elmira Bridge Company has the contracts for a number of bridges for the Lehigh Valley Railroad System. Among others, those for a new single-track, four-span bridge at Wilkesbarre, Pa., across the Susquehanna River, and a five-span, double-track bridge at Athens, Pa., across the Chemung River. The latter replaces an existing bridge considered too light for the heavy rolling stock. The Schuylkill Viaduct, at Schuylkill Haven, Pa., 1,450 ft. long, has just been opened for trains and the shops are now working on the Westwood Junction Bridge of two spans, one 155 ft. 9 in. and one 132 ft. long. These spans, with a number of large plate girders, keep the shops pretty busy.

THE Chicago, Burlington & Northern Railroad will bridge the Mississippi River at Winona Minn. Mr. George S. Morison is Consulting Engineer. Mr. Morison is also Consulting Engineer on the Mississippi River bridges at Burlington, Ia., to replace the well-known Chicago, Burlington & Quincy crossing, and at Memphis, Tenn., for the Kansas City, Fort Scott & Memphis. The latter, when completed, will be the largest cantilever span in the country, 790 ft. clear.

THE Louisville & Nashville Railroad has let contracts to bridge shops as follows: Edge Moor Bridge Works, 706 tons; Pencoyd Iron Works, 615 tons; Louisville Bridge & Iron

Company, 347 tons; Mount Vernon Bridge Company, 176 tons; Shiffler Bridge Company, 74 tons.

THE erection of the Newark Bridge on the New York extension of the Lehigh Valley is rapidly approaching completion. The bridge is a crossing of the Pennsylvania Railroad tracks and is of two heavy, double-track spans, one 154 ft. and one 168 ft. 9 in. It was built and is being erected by the Edge Moor Bridge Works.

THE Delaware, Lackawanna & Western has let the contract for the Delaware River bridge at Easton, Pa., to the Passaic Rolling Mill Company, of Paterson, N. J. It has five spans of 150 ft. each.

THE New York Central & Hudson River Company has let contracts for 22 highway bridges to the Rochester Bridge & Iron Works. The Elmira and the Hilton Bridge Companies are also doing considerable bridge work for this road.

THE Edge Moor Bridge Works have the contract for a 1,200-ft. viaduct in the city of Richmond, Va.

MR. A. P. BOLLER, Consulting Engineer for the Board of Public Works in New York, has awarded the contract for the One Hundred and Fifty-fifth Street viaduct to the Union Bridge Company. The total weight of the structure is about 4,000 tons. In general it will consist of plate girders resting upon columns. Date for completion is set at June 1, 1892.

THE Michigan Central has let the contracts for several bridges to the Pencoyd Iron Works, of Pencoyd, Pa.

THE Keystone Bridge Company has secured the contract for the Contentnea Creek bridge for the Atlantic Coast Line. It is a through Pratt truss span 112 ft. center to center of end pins.

THE contract for a highway bridge across the Mississippi River, between Lyons and Fulton, Ia., has been let to the Chicago Bridge & Iron Company. It consists of five spans, one 200 ft., three 330 ft., and one 360 ft. long and will be practically of steel with cylinder piers of iron. Total weight about 600 tons. Mr. C. F. Loweth, of St. Paul, is the engineer in charge.

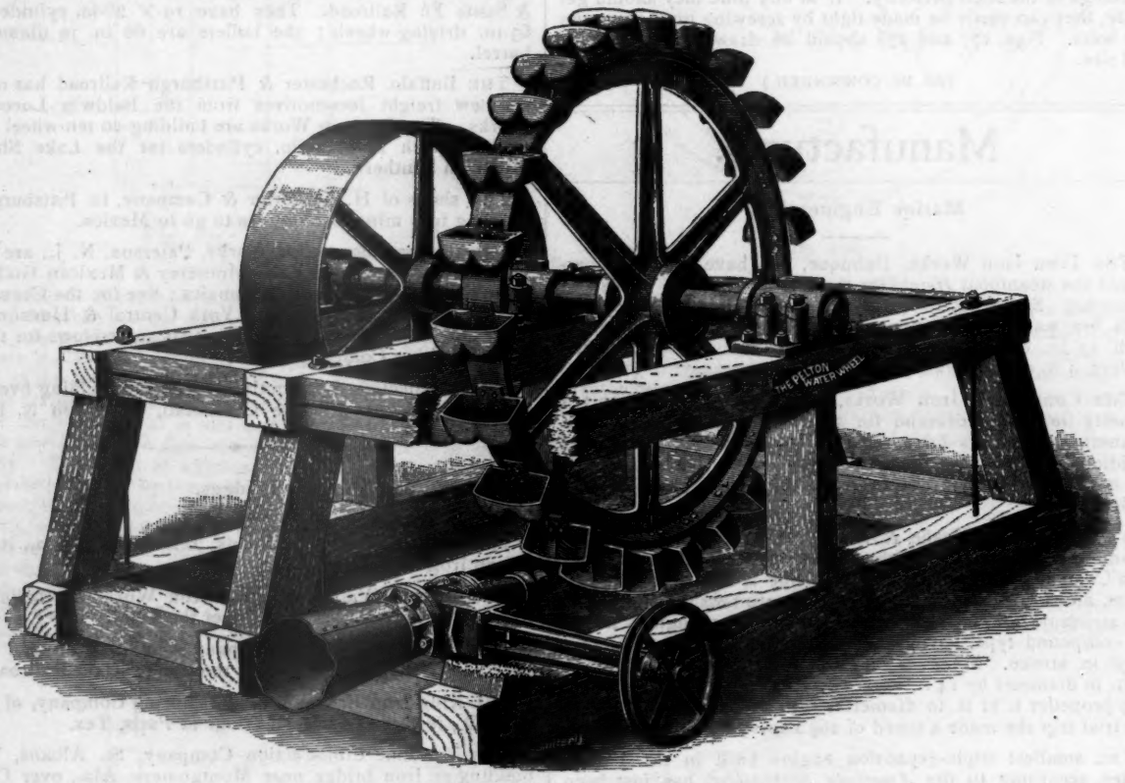
THE Pittsburgh, Allegheny & Manchester Traction Company has consolidated its interests with those of the Sixth Street Suspension Bridge Company, and will use the proposed Sixth Street Bridge across the Allegheny River at Pittsburgh, Pa. Plans have been submitted by Gustav Lindenthal and G. W. Ferris and while both have been recommended by Colonel Flad, it is probable that those of the former will be adopted.

THE new eyebar manufacturing plant and large testing machine of the Phœnix Bridge Company are now in working order, and eyebars for the St. Louis terminal to the Merchants' Bridge are being manufactured with fair success.

THE Delaware & Hudson Canal Company has let the contract for the bridge across the Hudson River and Canal at Fort Edward, N. Y., to the Hilton Bridge Company, of Albany. The bridge comprises nine deck lattice girder spans, as follows: Canal bridge, one span 105 ft., two spans 110 ft. and one span 121 ft. 9 in.; river bridge, four spans 105 ft. 9 in., one shore span 105 ft. 9 in. and one span 108 ft. 7 in. The contract calls for completion November 1, 1890.

The Pelton Water-Wheel.

THE Pelton water-wheel, which is coming into extensive use on the Pacific Coast, is a high-pressure wheel, the power of which does not depend so much on its diameter as upon the head and amount of water applied to it. As shown in the engravings, it is very simple in construction, and the only requirement as to size is that the wheel shall be large enough to carry buckets of the proper size to handle the stream applied.



THE PELTON WATER-WHEEL.

It may be described as a tangential, pressure and reaction wheel. It is simply a wheel of the proper strength, to the rim of which are attached buckets of the form shown, upon which the stream of water is directed by a nozzle placed below. This nozzle may be single and directed as shown in the engraving, or a double nozzle may be used, the latter arrangement being preferred with a low head of water, and also where the quantity of water available is variable.

The advantages claimed for this wheel are chiefly as follows:

1. Its great simplicity and the absence of wearing parts, which make it a very durable wheel. The only repairs needed usually are the renewal of the buckets.

2. The buckets being open, with a free discharge, it can be run with water carrying sediment, and the wheel is never clogged with roots or other foreign substances, or by ice in a cold climate.

3. The power may be varied widely without impairing the efficiency of the wheel. This is accomplished by simply chang-

ing the tip of the nozzle, varying the size of the stream. It can thus be adapted to a water-power where the supply is variable.

4. The simplicity of its mounting, the ease with which connections are made, and the fact that the wheel can be placed at any convenient point to which the water can be conveyed by a pipe. It is also claimed that, while the wheel can be run with a low head of water, it will utilize to the fullest extent a small stream with a considerable head.

It may be mentioned that there are six Pelton wheels now in operation at the Sutro Tunnel level of the Chollar Mine in Nevada, using water under a head of no less than 1,680 ft. These wheels run a Brush electric plant, from which power is furnished to the California Mill, the electricity being transmitted to the surface by steel cables. In this case the wheels used are 40 in. in diameter and are run at 900 revolutions per minute. These wheels are of phosphor-bronze, weighing 220 lbs. each; they are run with nozzles $\frac{3}{4}$ in. in diameter, and develop about 125 H.P. each.

At Aspen, Col., there is an electric-light and power plant which is run by eight 24-in. Pelton wheels; they run at 1,000 revolutions per minute under a head of 820 ft., and develop about 175 H.P. each. Reducing tips are used to the nozzles here, so that the power can be varied as needed. Water is carried to the power station by a single line of pipe, consisting of 500 ft. of 16-in. and 3,500 ft. of 14-in. pipe, discharging into a receiver, from which separate connections are made to each wheel.

The Pelton wheel seems especially adapted to the running of an electric station, as it can be run up to a high speed, and so can be connected directly to a dynamo, without using intermediate gearing or belting to increase the speed.

It also seems to be well adapted to small powers, and where it is possible or necessary to increase the power, the addition of more wheels is easily made.

In some cases a hydraulic governor is used, with a deflecting nozzle, and this arrangement has been found to work very well.

In the accompanying cuts fig. 1 is a perspective view of a wheel and framing; fig. 2 is an elevation, and fig. 3 a plan of a 6-ft. wheel of standard pattern. This is a large size, but shows very well the design and construction, which is substantially the same in all. The arrangement of the nozzle is, of course, varied where two or more are used.

This wheel is manufactured by the Pelton Water Wheel Company of San Francisco, Cal., who will furnish all necessary information.

The Blaine Vitrified Clay Tie.

In relation to the description of this tie, published in the August number of the JOURNAL, page 377, a valued subscriber and correspondent, Mr. Edward Hill, of Indianapolis, furnishes the following interesting particulars:

"The most important element in the tie is the vitrified clay base, which stands 10 in. high. The diameter on top is 10 in.; the bottom is oval in shape, the major and minor axes of the ellipse being 15 in. and 22 in. respectively.

"The first lot made were put under a freight track in the yard in Dayton, O. All the freight trains going east and west through the yard pass over this track, and the ties are to-day in as perfect condition as when put in three years ago.

"The clay blocks were tested for crushing in a wheel press, and withstood a strain of 55 tons before cracking, which took place longitudinally with the blocks. In laying they are spaced 16 in. center to center, which gives the track about the same bearing surface as with ordinary cross-ties. Every other set of blocks is connected together by the cross-bar. The cost of manufacture of these ties is about 70 cents.

"There is a wooden block on top of the clay base, which gives a surface similar to a wooden tie. Fire-clay vitrified and burned hard has about the same crushing strength of sandstone, and the philosophy of the clay tie bases is that they will not rot and are impervious to water, while the wooden block acts as a cushion to give some elasticity, similar to the surface of an ordinary wooden tie.

"The clay blocks are admirably adapted for street railroads in large cities, where good asphalt or other pavements are necessary; being of a permanent nature, they will not decay under the surface like timber."

OBITUARY.

GEORGE W. TILTON died in Chicago, August 17, aged 60 years. He was born near Manchester, N. H., and for several years was employed in the Manchester Machine Works. About 1858 he went to the Chicago, Burlington & Quincy shops at Aurora, Ill., as Foreman, and in 1860 was appointed Foreman of the Chicago & Northwestern shops at Fulton, Ill. In 1870 he was made Master Mechanic, and in 1875 was appointed Superintendent of Motive Power and Machinery for all the Chicago & Northwestern lines; in 1881 the Car Department was also placed under his charge. Mr. Tilton's death was the result of a slight accident on the road, a collision, which did not damage the car, throwing him forward and fracturing his skull, which struck the corner of a trunk. He was highly esteemed by the officers of the road and by all his associates.

PERSONALS.

EMIL KUICHLING has been appointed Chief Engineer of the water-works at Rochester, N. Y.

A. H. WATTS has been appointed Superintendent of Motive Power of the Cincinnati, Jackson & Mackinaw Railroad.

MAJOR GEORGE W. MCNULTY is Engineer of Construction of the new cable road and plant of the Broadway Railroad in New York.

W. H. V. ROSING has been appointed Division Master Mechanic on the Illinois Central Railroad. He has been Chief Draftsman of the road for several years.

ROBERT MILLER has been appointed General Superintendent of the Michigan Central Railroad. He has been on the road since 1876, at first as Master Car-Builder and later as Assistant General Superintendent.

A. W. GIBBS has been appointed Superintendent of Motive Power of the Central Railroad of Georgia, succeeding T. L. CHAPMAN, who has resigned. Mr. Gibbs was recently on the Richmond & Danville Railroad.

H. S. JACOBY has been chosen Assistant Professor in the College of Civil Engineering in Cornell University, Ithaca, N. Y., and will have charge of the department of Graphics and Bridge Engineering. Professor Jacoby has been for some time Assistant to Professor Merriman in Lehigh University.

T. A. FRASER has resigned his position as Master Mechanic of the Minneapolis, St. Paul & Sault Ste. Marie Railroad, to take charge of the car shops of the Wells & French Company, in Chicago. J. P. HOLLAND and F. A. HAINES accompany him there as Foremen. Their successors are EDWARD A. WILLIAMS as Master Mechanic, E. S. BARRETT as Foreman of Car Shops and L. C. HITCHCOCK as General Foreman of the Machine Shop.

PROCEEDINGS OF SOCIETIES.

American Association for the Advancement of Science.—The annual meeting of this Association began in Indianapolis, August 20. A general meeting was held on the first day, at which addresses of welcome were made, the reports of the General Secretary and of the Council read, and other routine business transacted. As usual, the Association then separated into sections for the reading of papers and discussions, the sections being as follows: A, Mathematics and Astronomy; B, Physics; C, Chemistry; D, Mechanical Science and Engineering; E, Geology and Geography; F, Biology; H, Anthropology; I, Economical Science and Statistics.

The section on Physics was presided over by Professor Cleveland Abbe, and that of Engineering by Professor Denton, of the Stevens Institute. His opening address was on the History of Attempts to Determine the Relative Value of Lubricants by Mechanical Tests.

The meeting continued for a week, a large number of papers being read in the various sections. It was diversified by excursions to Terre Haute, where the members visited the Rose Polytechnic Institute, and a number of manufacturing establishments, and by a trip through the Natural Gas Belt of Indiana, including the towns of Kokomo, Marion, Muncie, and Anderson.

Among the papers of interest read in the mechanical section were several by Professor Thomas Gray on Testing Materials; by Professor W. A. Rogers on the Dividing Gauges; and by Mr. William Kent on the Standard Efficiency for Steam Engines.

At the meetings of the Council the usual action was taken on committee reports, and the memorials were adopted to Congress on the advisability of making the metric system a standard in

all government transactions, and on the adoption of measures for the protection of forest lands.

At the concluding general business session a number of new members and fellows were elected. It was decided to hold the next meeting in Washington, in August, 1891. The following officers were elected for the ensuing year:

President, Albert B. Prescott, Ann Arbor, Mich.

Vice-Presidents: A, Mathematics and Astronomy, E. W. Hyde, Cincinnati, O.; B, Physics, F. E. Nipher, St. Louis; C, Chemistry, R. C. Kedzie, Agricultural College, Michigan; D, Mechanical Science and Engineering, Thomas Grey, Terre Haute; E, Geology and Geography, J. J. Stevenson, New York; F, Biology, J. M. Coulter, Crawfordsville, Ind.; H, Anthropology, Joseph Jastrow, Madison, Wis.; I, Economic Science and Statistics, S. Dana Horton, Pomeroy, O.

Permanent Secretary, F. W. Putnam, Cambridge, Mass.

General Secretary, Harvey W. Wiley, Washington, D. C.

Secretary of the Council, A. W. Butler, Brookville, Ind.

Auditors, Henry Wheatland, Salem, Mass., Thomas Meehan, Germantown, Pa.

Secretaries of Sections: A, Mathematics and Astronomy, E. D. Preston, Washington, D. C.; B, Physics, A. N. Macfarlane, Austin, Tex.; C. Chemistry, F. H. Norton, Cincinnati, O.; D, Mechanical Science and Engineering, William Kent, New York; E, Geology and Geography, W. J. McGee, Washington, D. C.; F, Biology, A. J. Cook, Agricultural College, Michigan; H, Anthropology, W. H. Holmes, Washington, D. C.; I, Economic Science and Statistics, B. E. Fernow, Washington, D. C.

Treasurer, William Lilly, Mauch Chunk, Pa.

The attendance at this meeting was large and the meeting was considered generally a very successful one.

American Institute of Mining Engineers.—As heretofore announced, the fall meeting was held in New York, September 29 and 30, but this meeting was to be chiefly preparatory to the joint meeting with the Iron and Steel Institute of Great Britain, the American meeting of that body beginning October 1.

Iron and Steel Institute.—The programme for the American meeting of this body is announced as follows: The first meeting to be held in New York on the morning of October 1; in the afternoon the members, with those of the Institute of Mining Engineers, proceed on an excursion up the Hudson River. On October 2 the unveiling of the Holley memorial in Washington Square takes place, and an address is delivered in Chickering Hall by Mr. James Dredge.

After the various excursions the programme announced is as follows: On October 4 the members will proceed by special train to Philadelphia remaining there until October 7, when they will proceed to Lebanon and Harrisburg, and on the following day to Johnstown and Altoona, arriving at Pittsburgh in the evening. At Pittsburgh an international meeting will be held, at which a number of papers will be read. A list of these papers and also of those to be read at the New York meeting has already been published.

The general excursion will proceed from Pittsburgh to Chicago, and at the close of the visit to Chicago will divide into two parties, going respectively North and South. The Northern excursion will visit Menominee, Gogebic, and Marquette iron ranges and the Lake Superior copper district, returning to New York *via* the Sault Ste. Marie Canal, the Sudbury (Canada) nickel and copper mines, and Niagara; while the Southern excursion will go from Chicago to Birmingham, Shelby, and Anniston, Ala., returning to New York *via* Chattanooga, Tenn., Middlesborough, Ky., Roanoke, Cripple Creek iron mines, Pocahontas coal mines, Luray, Va., and Washington. Both excursions will reach New York about October 28.

American Society of Civil Engineers.—The first meeting of the session was held in New York, September 3, when the usual routine business was transacted and notes on a mountain slide by William J. Curtis were read, the paper being afterward discussed by members present.

Engineers' Club of Cincinnati.—At the July meeting a committee of two was appointed to investigate the question whether the Club should become a member of the Association of engineering societies.

The following question was presented and received considerable discussion, which was taken part in by Messrs. Nicholson, Whinery, Ruggles, and Schenk: "In a City of 300,000 inhabitants what is the smallest quantity of water per capita per day necessary for the necessities and comforts of its citizens, provided there is neither waste nor unnecessary use of the water?"

Mr. Ruggles read a very interesting historical sketch of the Ohio & Mississippi Railway which embraced a valuable collection of information concerning one of the earliest railways of the country.

Dr. P. H. Dudley, of New York, who was present—having recently returned from an inspection trip with his dynagraph car over the roads of the Queen & Crescent System—entertained the meeting with a description of his apparatus and exhibited some diagrams of the work performed by it.

AT the August meeting the committee appointed at the previous meeting presented a partial report.

The question presented for discussion was: "What would be the effect in the case of a Howe truss bridge that had given indications of failing generally, of putting in a support of piles or similar temporary bents midway of the span? What would be the effect if it were a combination bridge or Warren girder?" was discussed by Messrs. Merrill, Stuart, and Nicholson.

Papers on the following subjects were read:

1. Cement Tests, by Philip J. Schopp.
2. Some ideas about River Engineering, by Oswald Dietz.

The latter comprised a suggestion for the establishment of a school for experimental hydraulic engineering.

The first paper, while in itself giving only the results of some experiments on cements, especially on some that had become set by becoming submerged, opened up the always interesting subject of cement and its use, which was discussed quite generally.

New England Roadmasters' Association.—The Eighth Annual Convention was held in Boston, August 20. The following officers were elected for the ensuing year: President, W. E. Clark, Vermont Valley; Vice-President, F. C. Clarke, Housatonic; Secretary and Treasurer, G. S. R. French, Boston & Maine; Chaplain, E. W. Horner, Central Vermont; Executive Committee, C. B. Lentell, F. D. Holbrook, E. W. Horner, and A. C. Stickney.

The first report presented was on Track Repairs in the Winter and Spring Months, and suggested that the use of proper material for road-beds was the best means of preventing injury from frosts, and that six miles of single track, or four miles of double track were the best lengths for sections.

The Committee on Inspection of Road-bed presented a report recommending frequent inspections, and also approving of the system of premiums to section masters. In the discussion of these interesting questions some of the methods of inspection adopted on the Boston & Albany and other roads were given.

On the second day the Committee on Frogs and Switches presented a report which was very fully discussed, members giving their opinions and experience. A great difference of opinion as to the relative merits of the rigid frog and the spring-rail frog was developed, with the balance somewhat in favor of the spring-rail frog. The general opinion was that the greatest cause of wear to frogs and switches was the use of poor and defective wheels.

Reports were also presented on improvements in nut-locks rail saws, tie-plates and other devices.

It was voted to hold the next meeting in Boston on the third Wednesday in August, in 1891. The meeting concluded by a trip to North Adams and through the Hoosac Tunnel, over the Fitchburg Railroad.

Master Mechanics' Association.—Secretary Angus Sinclair has issued a circular giving the Committees for conducting the business for the current year as follows:

1. Exhaust Pipes, Nozzles and Steam Passages. Investigate best form and size in proportion to cylinders: C. F. Thomas, A. W. Gibbs, L. C. Noble, F. C. Smith, John Y. Smith.

2. Testing Laboratories, Chemical and Mechanical: George Gibbs, Phillip Wallis, G. W. West, L. S. Randolph, D. L. Barnes.

3. Advantages and Disadvantages of Placing the Fire-box above the Frames: Fred B. Griffiths, James Macbeth, W. A. Foster, A. G. Leonard, Louis F. Lyne.

4. Relative Value of Steel and Iron Axles: John Mackenzie, J. S. Graham, John S. Cook, W. B. Wall, Thomas Shaw.

5. Purification or Softening of Feed Water: W. T. Small, Harvey Middleton, A. W. Quackenbush, J. B. Barnes, John W. Hill.

6. The Present Status of the Car Coupler Question. Investigate whether this Association can indorse the action of the Master Car-Builders' Association from a mechanical standpoint

in recommending the Vertical Plane Type as a standard: John Hickey, G. W. Rhodes, Sanford Keeler, R. H. Blackall, M. N. Forney.

7. Examination of Locomotive Engineers and Firemen. On their duties relating to the use of fuel, care of the locomotive, and ability to deal with disorder or disability of machinery; to what extent practised, and best plan for conducting the examination: W. H. Thomas, John Player, F. D. Casanave, J. W. Luttrell, L. R. Pomeroy.

8. Operating Locomotives with Different Crews. Investigate the comparative advantages of operating locomotives with different crews on the "first in and first out" plan, and that of confining men to certain engines, the latter not running a greater number of miles than can be rendered by their regular crews; discuss any improvement in the method of running engines: Ross Kells, W. W. Reynolds, W. F. Turrell, C. G. Turner, John A. Hill.

9. Locomotive for Heavy Passenger and Fast Freight Train Service. Investigate the types best suited for this service and the relative economy and safety of eight-wheel, ten-wheel, and mogul locomotives for the service in question: Pulaski Leeds, James Meehan, E. M. Roberts, C. E. Smart, W. A. Smith.

10. Electrical Appliances for Railroad Use. Report on the progress of electricity in motive power, car lighting, signaling, welding, and kindred uses: T. W. Gentry, G. B. Hazelhurst, Albert Griggs, John Ortton, F. W. Dean.

11. Standards of the Association: William Swanston, William Garstang, C. H. Cory, J. S. McCrum, Thomas Shaw.

Disposal of Boston Fund: J. N. Lauder, J. N. Barr, Angus Sinclair.

To Confer with Committee of Master Car-Builders' Association on Bringing Conventions Closer Together: O. Stewart, Charles Graham, David Clark, G. W. Stevens, John Mackenzie.

On Subjects for Investigation and Discussion: William H. Lewis, John Wilson, Peter H. Peck.

Executive Committee and Trustees of Boston Fund and Printing Fund: John Mackenzie, John Hickey, William Garstang, O. Stewart, Angus Sinclair.

Custodian of Boston Fund: J. H. Setchel.

Roadmasters' Association of America.—The Eighth Annual Convention began in Detroit, Mich., September 9, with a large attendance. A number of new members were admitted. The morning session was occupied by the usual routine proceedings.

The Committee on Nut-Locks, Track-Bolts and Spikes presented a report recommending for general use an elastic steel nut-lock washer. For track-bolts ⅞-in. bolts were recommended for rails under 60 lbs.; ¾-in. for rails from 60 to 80 lbs., and 1-in. for rails weighing more than 80 lbs.; hexagonal nuts to be used, with standard threads. Steel spikes were recommended: the best size for general use being $\frac{9}{16}$-in. square and 5½ in. long. On rail-joints the Committee recommended five joints as worthy of trial by the Association: The Weber joint; the Long truss joint; McConway & Torley's reinforcement for angle bars; the improved Fisher joint, and the Cloud joint. These include a supported joint; a suspended joint, and a means of reinforcing existing joints. This report was received and the Executive Committee was instructed to conduct tests of the joints named and to report at the next Convention.

The Committee on Best Method of Instructing Section Laborers presented a report recommending a system of instruction for young laborers and the appointment of assistant foremen on probation. This called out considerable discussion and the report was referred back for further consideration.

At the second day's session the Committee on Interlocking Switches and Signals submitted a report including drawings and descriptions of the Saxby & Farmer machine; the Union Switch & Signal Company's electro-pneumatic apparatus, and the Johnson Signal Company's machines. On this report there was a brief discussion.

Mr. J. W. Craig read a paper comparing the mileage and statistics of railroads in different countries.

The Committee on Best Method for Preserving Cross-Ties presented a carefully prepared report on the different processes for preserving wood, including the creosote, the chloride of zinc, the sulphate of copper, and other processes, with statements of the methods adopted and the expense involved. The discussion of this report was postponed until the next Convention.

The following officers were elected for the ensuing year: President, John Doyle, Detroit, Lansing & Northern; First Vice-President, W. H. Stearns, Chicago & Northwestern; Second Vice-President, James Sloan, Chicago & Eastern Illinois; Secretary and Treasurer, J. P. Ramsay, Cincinnati, Hamilton & Dayton.

It was decided to hold the next Convention at Minneapolis.

South & Southwestern Railroad Club.—This new Club has been organized and will hold its meetings in St. Louis. The first meeting after organziation was to be held on September 25, when a constitution and by-laws were to be submitted.

The officers are: President, E. S. Marshall; Vice-Presidents, William Garstang, J. J. Casey; Secretary, W. H. Marshall.

Western Railroad Club.—The first meeting of the season was held in Chicago, September 16. A Committee report on two unfinished subjects: Relative Cost of Maintaining Rigid Center and Swing Beam Trucks of Freight Cars and Comparative Flange Wear of Wheels, was presented and discussed.

Northwestern Railroad Club.—The first meeting of the season was held in St. Paul, Minn., September 6. The subject for discussion was Fire-Box and Boiler Construction, on which a paper was read by William McIntosh, recommending the use of steel and referring to the Wootten and Belpaire fire-boxes. This paper was discussed by members present.

NOTES AND NEWS.

Ship Canal to Berlin.—One of the results of the great interest now felt in waterways in Germany is a project for a ship canal to connect Berlin with the sea, an outline of which is published in the *Deutsche Bauzeitung*. This project is favored by the generally level nature of the country and the supply of water furnished by the numerous rivers.

Four lines are indicated, any one of which is practicable. The first starts from Hamburg and runs on the south side of the

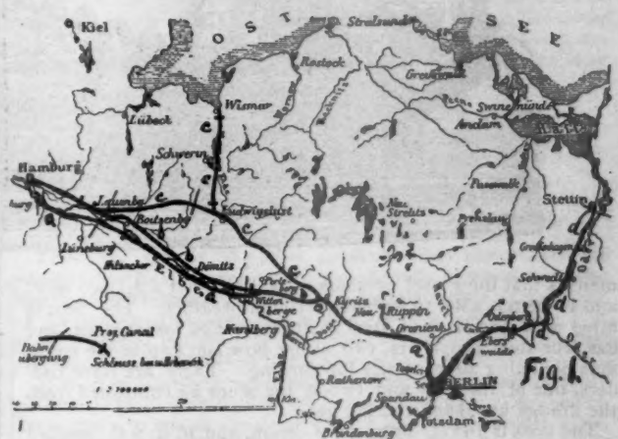


Fig. 1.

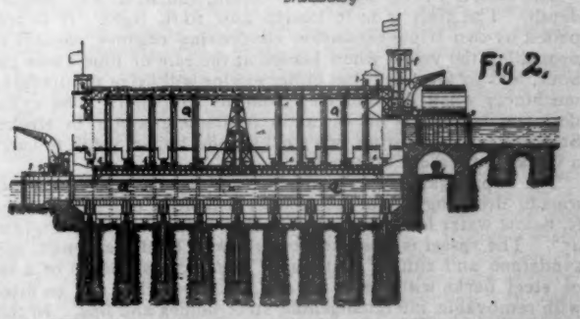


Fig 2.

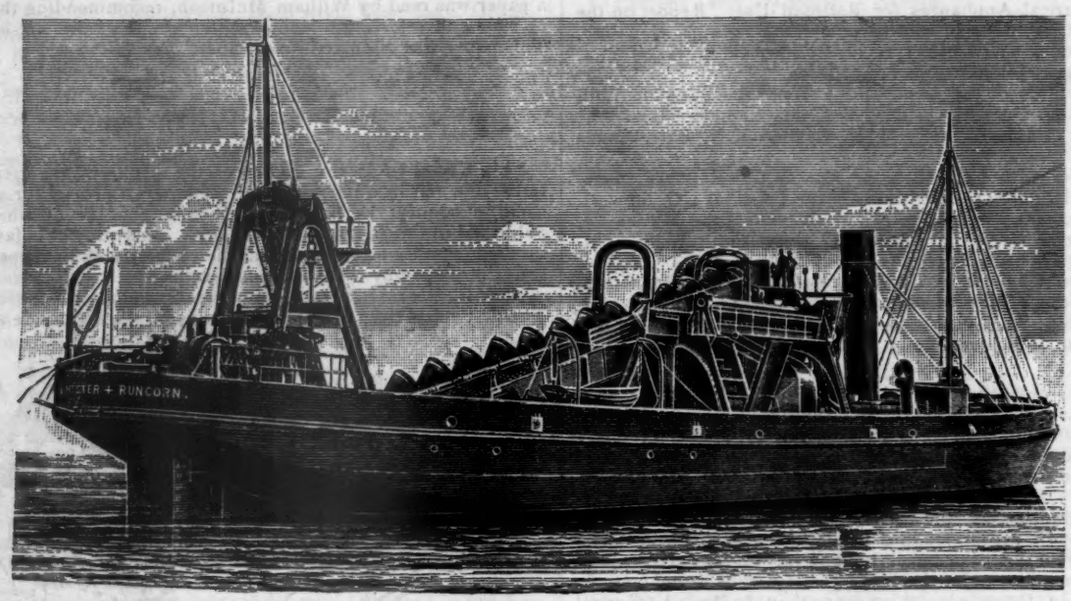
Elbe to Wittenberg, thence eastward to the Havel and south along that stream to Berlin. The second follows the north side of the Elbe to Wittenberg, where it joins the first line. The third leaves the second at Lauenberg, about 14 miles from Hamburg, runs east to Ludwigslust and thence southeast to the first line at Kyritz. The length of these lines is from 160 to 170 miles. The third line has a branch to Wismar on the Baltic Sea. The fourth line is entirely distinct, running from Berlin northeast to the Oder River and then following that river to Stettin; it is about 85 miles long.

The projected lines are shown by the heavy black lines on the accompanying sketch map, fig. 1, the first line being marked

a a a; the second *b b b*; the third *c c c*, and the fourth *d d d*. But few locks would be required; their position is shown in fig. 1 by the black cross lines on the canal.

It is proposed to use the hydraulic lift lock, which has been successfully employed in France and England, by which a greater lift can be secured with a smaller waste of water. A section of one of these locks is shown in fig. 2. The lock or water-box *a a* is raised and lowered by hydraulic lifts set below it, the pumps being placed in the building at the head of the lock. The dimensions proposed are 312 ft. long, 41 ft. wide and 21.3 ft. deep, which would permit the passage of vessels of large size.

A New Hopper Dredge Boat.—The accompanying illustration shows the steam dredge *Manchester*, recently built by the firm of William Simonds & Company in Renfrew, Scotland, for the Manchester Ship Canal. It is a single ladder, stern-well, hopper dredger, built of steel, and having some interesting details of construction, in which it differs from other dredge-boats previously built. The first point of difference is the division of the stern for the projection of the bucket ladder, other dredges having this division at the bow. The advantage of the new arrangement is that the vessel presents a solid and not a divided bow, and is better able to withstand rough weather. The boat is fitted with two lines of steel shafting carried fore and aft, and has four steel propellers, two at the bow and two at the stern, thus obviating all necessity for turning. There are three rudders, one at the bow and two at the stern all controlled from the dredge by steam steering gear.



The boat is 190 ft. long; 39 ft. beam, and 16 ft. 6 in. molded depth. The draft is 14 ft. loaded and 10 ft. light. It is propelled by two triple-expansion condensing engines, capable of propelling the vessel when loaded at the rate of nine knots per hour, and so arranged that either engine will drive the dredging machinery when disconnected from the propeller. The cylinders are 15½ in., 25 in. and 41 in. in diameter and 27 in. stroke. Steam is furnished from two steel tubular boilers, built to carry a working pressure of 150 lbs.

The hoppers are placed amidships and have a capacity for 850 tons of dredging, while the dredger will work to a depth of 35 ft. below water level when the bucket ladder is at an angle of 45°. The vessel is designed to deal with hard clay, mud, soft sandstone and similar material. The buckets consist of a set of steel backs with links so designed that they can be fitted with removable interchangeable steel bodies and lips. In this way the large bodies can be removed from the chain without breaking its continuity; when hard material is to be dealt with a set of special steel bodies of less capacity can be fitted on, every third back being armed with a set of ripping claws or picks for disintegrating the material. A friction connection is fitted between the engines and the top tumbler for the purpose of taking the strains arising from sudden shocks to the machinery when working in hard ground. At a trial near Greenock this dredge loaded clay at the rate of 1,000 tons per hour.

The Largest Reservoir.—The *Indian Engineer* says that, omitting lakes, which are in many cases natural reservoirs, the largest reservoir or artificial lake in the world is the great tank of Dhebar, 20 miles southeast of Udaipur, Rajputana, which covers an area of 21 square miles. The masonry dam is 1,000 ft. long by 95 ft. high; 50 ft. wide at the base and 15 at the top. In Southern India also, there are some immense reservoirs. That of Cumbum, is formed by damming the Gundlakamana River by a dam 57 ft. high, thrown between two hills. This reservoir has an area of 15 square miles. The Sulekere Reservoir in Mysore is a very little smaller, and, next to Cumbum, is the finest in Southern India.

The Generation of Electricity by the Flow of the Tide.—A French engineer, M. Decœur, has elaborated a project by which he proposes to supply electric power to Paris. He would generate the required electricity by utilizing the flow of the ebb and flood on the coast, and transmitting it to the French capital. For this purpose he intends to construct, near Havre, two large basins joined to each other, into one of which the sea at flood tide flows over a dam, while during ebb it flows out of the other into the sea again. At the inlet and outlet, M. Decœur proposes to erect a number of powerful turbines for transmitting the energy of the water. The mechanical energy thus produced M. Decœur estimates, with a tide of 18 ft., which is the average at Havre, at 6 H. P. per hectare of basin area. He intends parting off, by means of a dam 16½ miles long an area of 7,000 hectares between Havre and Tancarville from the sea and the Seine respectively, and thus creating 42,000 H.P., which power he will transform into electrical energy and transmit to Paris. M. Decœur's scheme is looked upon with favor, and there are indications that it will ultimately be carried out.—*Iron*.

An Electric Power Hammer.—In the operation of power hammers for forging heavy work it is necessary that the hammer shall be able to strike directly upon the anvil or at any distance from it within the range of its stroke. To carry out this object in connection with an electric hammer, Mr. C. J. Van Depoele employs the well-known construction shown in the engraving, fig. 1, which consists in the operation of an iron piston acted upon by a series of coils, which raise and lower the hammer according to the position of the switch governing the current passing to the coils. The special object of the construction adopted, however, is to obtain the range of motion. The piston reciprocates continually during the operation of the machine in a constant but changing field of force, within which it may be said to float, rising and falling in accordance with the rise and fall of current above and below it, and, by moving the shifting field of force to any desired part of the motor-coils, the position in which the piston and connected parts will reciprocate can be changed at will and a blow delivered wherever desired—that is to say, the hammer can be made to strike directly upon the anvil or any distance therefrom within the limit of the coils.

The manner in which this is effected will be readily understood by reference to the diagram, fig. 2. Here *J* is a sectional commutator representing a source of continuous current; j^1 j^2 are the main positive and negative commutator-brushes, which are fixed upon the line of commutation; *j* is a moving commutator brush, the office of which is to cause the supply-current to rise and fall in the motor-coils by being moved around the

commutator toward and away from the points of maximum and zero electromotive force. The brush, j^1, is connected with a contact-brush, K^1. The commutator-brush, j^2, is similarly connected with a brush, k^2, and the moving brush, j, is connected with a brush, k. The brushes, $k\,k^1k^2$, are secured in a fixed relation to each other in an insulated carrier, L, fig. 1,

Fig. 1.

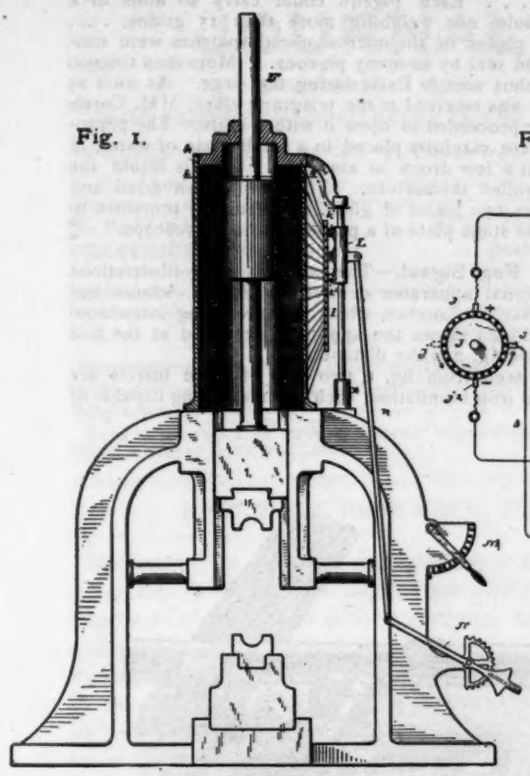
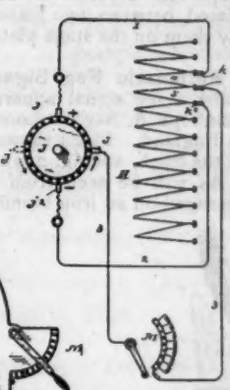


Fig. 2.



and maintained in contact with the commutator, i. With the positions shown in fig. 2 current would flow through brush j^1, brush k^1, into coil 4, through coil 5, out through brush k^2, and back through brush j^2 to the commutator, J. The moving brush, j, being in central position, and, therefore, conveying no current in its travel about the commutator toward and away from the fixed brushes, will cause the current to fall in one of the motor-coils and rise in the other, and so on, so long as the brush, j, is kept in motion, it being apparent that the current which is continually rising and falling in the motor-coils is constant in direction and maintains a field of force which is gradually shifted back and forth between the coils in circuit with the brushes, $k\,k^1\,k^2$; from which it follows that the piston, G, will move within the active coils, no matter in what part of the machine they may be. The current, never being interrupted or broken, the piston will therefore float within the coils without being able to escape in either direction. The speed at which the brush j is moved will determine the rate of reciprocation of the plunger, G, and in order to most conveniently regulate the power of the apparatus an adjustable resistance, M, is connected in the circuit, as shown.

As a convenient means of conveying current through the circuits, the brushes $k\,k^1\,k^2$ are, as stated, mounted in fixed relation to each other in a movable carrier L which is sustained in front of the commutator I. In order to vary the stroke of the piston the brush-carrier L is adjusted up or down by means of a latch-lever N and a connecting-rod. The lever N is located in a position convenient to the workman operating the machine, and the adjustable resistance M is also located in convenient proximity.

Increasing Traction by Electricity.—Experiments are now in progress on the Baltimore & Ohio Railroad with the system of electrically increasing traction, or rather adhesion, devised by Mr. Elias E. Ries and owned by the Ries Electric Traction & Brake Company, of Baltimore. The apparatus is fitted on No. 777, an ordinary eight-wheel passenger locomotive. The traction-increasing current is generated by a small alternating current dynamo driven by a rotary engine supplied with steam from the locomotive boiler. The engine and dynamo are mounted upon a common base secured to the boiler in the position formerly occupied by the sand box. One or both pairs of driving-wheels are electrically insulated from the body of the locomotive and from each other by the use of special insulation surrounding the driving-box and side-rod brasses. The insulation so far employed has proven itself fully capable of withstanding the exceptionally severe strain to which it is subjected, and tests made after several months of continuous service have led to its permanent adoption for this class of work.

Electrical connection with the two pairs of drivers is maintained by means of peculiarly constructed brushes bearing upon brass sleeves secured to the central portion of each driving axle. These brushes are connected, by means of heavy stranded copper conductors, with the source of low tension current, which in this case is a transformer placed in proximity to the main driving-axle. A type of machine is now about to be used, however, which generates directly the low-tension quantity currents required. As the resistance of the traction-increasing circuit is practically constant under given track conditions, the flow of current is usually regulated by varying the electro-motive force, which, on account of the low resistance of the circuit and multiple connection of the driving-wheels, can be kept very low. The current density at the points of contact between the driving-wheels and rails can be varied at will, according to the percentage of increased adhesion desired, the usual range being from 500 to 2,500 amperes.

It is proposed to use part of the current generated by the dynamo, either directly or indirectly, according to the type of machine employed, for the operation of electric locomotive and train brakes, electric headlight and train lighting, etc., in addition to its use for increasing traction. The dynamo is generally kept running at a slow rate of speed when not otherwise employed, and is so constructed as to respond promptly and automatically to any demand that may be made upon it within the limits of its capacity.

It is claimed that the tests so far made show that the adhesion of a locomotive of ordinary weight can be increased fully 25 per cent. by the Ries apparatus.

Electric Street Railroads.—According to figures compiled recently there are now nearly 9,000 miles of street car track in this country and Canada. The figures furnished by the *Street Railway Journal*, in response to an inquiry, are as follows, being derived from the latest returns received from street railway companies:

Miles of Horse railroad.....	5,902
" " Electric "	1,753
" " Dummy "	556
" " Cable "	441
Total mileage.....	8,652

There are now in operation 44 cable roads and 264 electric roads. The total number of street railroads is about 1,000, so that the lines operated by electricity include about 25 per cent. of the roads and about 20 per cent. of the total mileage. This is an excellent showing for the comparatively short time that electricity has been in use on railroads.

It is no wonder that the problems of street railroad work are so attractive to electrical inventors and electrical engineers. They begin to realize the magnitude of the field, its possibilities, and the fact that it is theirs in a peculiar and special way. It is also a good training school for the heavier work that awaits beyond in operating many of the present steam railroads.

The work of the street railroads in the urban transportation of our people is enormous. In St. Louis it has been found that the whole population is carried 110 times a year by the street cars. In the State of New York the surface street railroads, 91 in number, carried 368,496,648 passengers during the year ending September, 1889, or the whole population of the State 50 or 60 times. If we added the 217,000,000 of the elevated roads, it would make the population of the whole Empire State ride not less than 80 or 90 times a year in the street cars. Probably such high ratios do not apply over the whole country, but the figures are still very striking, even if minimized. There are slightly over 29,000 street cars, open and closed, in America. If, say, 18,000 of these are in daily commission and carry no more than 200 passengers each, the total number of passengers is not less than 1,314,000,000 per annum. This would give every inhabitant of the United States about 20 car rides a year.

Evidently street railroad work is rapidly assuming gigantic proportions, and as it grows it opens up a larger and larger area for electrical engineering and electrical productions.—*Electrical Engineer.*

A New Incline Railroad.—An incline railroad for passenger traffic, built on Cameron Hill, in Chattanooga, Tenn., is described in a paper recently read before the Engineering Asso-

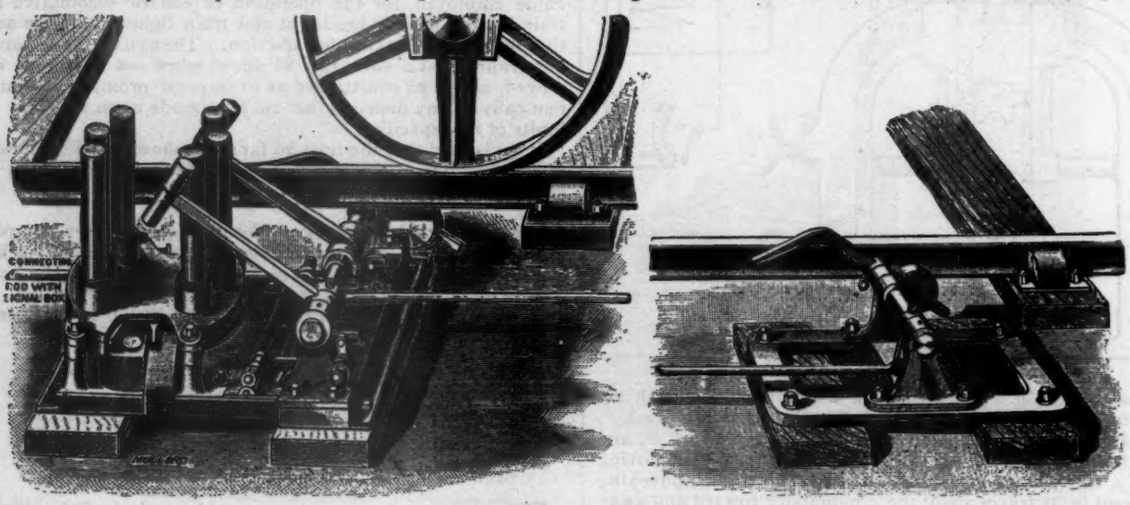
ciation of the Southwest. This road is owned by the Chattanooga Water & Power Company, and was designed and built by Messrs. Guild & White, Civil Engineers, in that city. It was opened for traffic in October last. The road is a double-track line of three rails, with a fourth rail at the center passing point. The incline is 1,495 ft. long, rising 300 ft., the minimum grade being 1 per cent.; the maximum, 31 per cent., and the average grade, 20 per cent. The car floors and seats are built to be level at the average. The cars, two in number, are attached by permanent grips to opposite sides of the 1-in. hauling cable, which passes through the driving machinery at the top of the incline. This machinery has to be reversed at the end of every trip. The alignment is straight except for 100 ft. of 6° 40′ curve to the left ascending, and 150 ft. of 10° curve to the right. The gauge of the track is 4 ft., and the length of the ties for double track is 12 ft. The rails are laid directly on stringers 7 in. × 12 in. in size and 16 ft. long, which are bolted to the tops of the ties, in order to give room for the cable conduit on those portions of the lines occupying city streets. The cars have a seating capacity of 30 passengers, and can be stopped at any point by electric signals from the conductor to the engineer at the power station, these signals being transmitted through an overhead wire with which connection is maintained by a traveling trolley projecting from the top of the car. To insure the prompt starting of the descending car, which may have been stopped on the nearly level portion of the line, a ¾-in. tail-cable passes from each car to the foot of the incline, around the tension sheaves, and returns to the other car, thus attaching both to an endless cable, whose direction of motion is reversed for every trip. The slack of the cable is taken up by a movable tension carriage at the foot of the incline, which works against stiff springs, and has a travel of about 3 ft. Provision for holding the cars in the event of a break of the cable includes a sector brake-shoe, which falls under the wheels and into which the wheels roll, forcing down a V-shaped grip upon the rail-head. Trials of this brake show that it will hold the cars motionless on the steepest portion of the incline. To prevent danger from possible over-winding, the upper extension of each track ends in a level piece of track, the end of which is on level ground, from which the cars cannot return to the rails unaided. The trip over the incline occupies about three minutes.

Photography in War.—A writer on this subject in *Broad Arrow*, alluding to the reproduction of dispatches intended to be sent by carrier-pigeons, says that in this branch no sensible progress has been made since the siege of Paris, during which the French employed photography to this end with surprising ingenuity and completeness, and we cannot perhaps do better than quote what was written on the subject by the French savant, Gaston Tissandier:

"No one can have forgotten the service rendered by balloons during the siege of Paris, nor the wonderful part played by carrier-pigeons, which brought to the besieged city news from the outer world. But these birds, however strong they might be, could only carry with them very light burdens through the air. A thin sheet of paper two or three inches square was all the load that could be intrusted to these winged messengers. But how write orders, send dispatches, give precise instructions in such a minute letter? The most able caligrapher could hardly make it contain the letters in a single page of a printed volume. Microscopic photography came to the assistance of the besieged; it solved the difficulty as no other art could have done; it reproduced on a film of collodion weighing less than a grain more than three thousand dispatches, that is to say, the amount of sixteen pages of folio printed matter. . . . Several of these films, representing a considerable number of dispatches, were rolled and enclosed in a quill about the size of a toothpick. This light and novel letter-box was attached to the tail of a pigeon. . . . Each pigeon could carry 20 films in a quill, the whole not weighing more than 15 grains. . . . Thirty or 40 copies of the microscopic despatches were usually printed and sent by as many pigeons. More than 100,000 of them were thus sent to Paris during the siege. As soon as the small tube was received at the telegraph office, MM. Corun and Mercadier proceeded to open it with a knife. The photograph films were carefully placed in a small basin of water, in which were put a few drops of ammonia. In this liquid the dispatches unrolled themselves. They were then dried and placed between two plates of glass. It then only remained to lay them on the stage plate of a photo-electric microscope."

Automatic Fog Signal.—The accompanying illustrations show a fog signal apparatus devised by Robert Adams and Stanhope A. Say, of London, which is now being introduced in England. Fig. 1 shows the apparatus arranged at the side of the track, and fig. 2 is the distant arm.

As will be seen from fig. 1, two sets of three turrets are arranged on an iron foundation, each cylinder being capable of



containing 40 cartridges, or 240 in all. These detonators are placed in the vertical cylinders by hand, and in actual working are passed into annular spaces at the bottom of the chamber by the arms of a horizontal disk, which revolves on a vertical axis. To the latter is fixed a ratchet wheel, which is revolved by means of a pawl, which is connected with the rod communicating with the lever in the signal-box. Thus, on the signalman pulling over the lever, the pawl is released, and the ratchet wheel turns the distance of one tooth, the horizontal disk also making part of a revolution. This causes a cartridge to be placed on each of the two anvils, one of which only is shown in the illustration. Of these anvils, one is arranged on the left-hand and the other on the annular chamber, in open spaces of which they are fixed. Sufficient space is left for the reception and expulsion of the exploded cartridges, the latter being effected by the arms of the horizontal disk.

There are two hammers which partly revolve on the shaft shown. These hammers are raised by a pull of the signalman's lever and are held in position by a pawl. Simultaneously with the lifting of the hammers two elbow levers, placed close and almost in contact with the rail, are raised. One of these levers is shown near the portion of the wheel in fig. 1. and the other in fig. 2. The first lever is fixed on the shaft on which the hammers turn, while the second lever or distant arm is mounted upon a second shaft (fig. 2), placed at any suitable distance away, but close to the same rail, and connected by a rod to a loose lever working on the hammer shaft. Thus, on a train passing over the elbow lever, they are depressed sufficiently to detach the pawl holding the hammers in their raised position. The hammers, being released, fall with great force and explode the cartridges. The spent cartridges are removed, and the hammers and elbow levers again raised to their usual position by the signalman pulling over the lever in the manner already explained. When the apparatus is worked from the signal-box the same levers which are used in connection with the semaphores can be arranged for the double purpose.